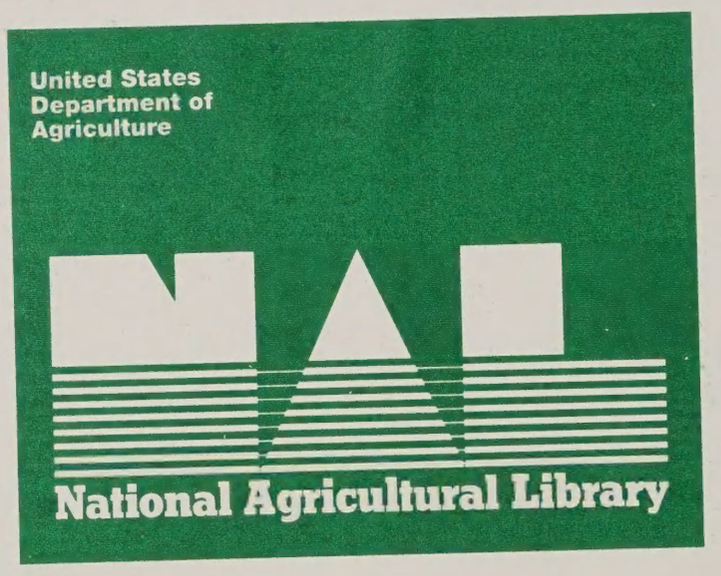
Vegetable Research Needs for the Southern Region

Joint Task Force of the Southern Region Agricultural Experiment Stations and United States Department of Agriculture Scientists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VEGETABLE RESEARCH NEEDS FOR THE SOUTHERN REGION

Prepared by:

Joint Task Force of the Southern Region
Agricultural Experiment Stations and
United States Department of Agriculture
Scientists

May, 1974

TABLE OF CONTENTS

PREFACE

This report was prepared by a joint task force appointed by the Directors of Agricultural Experiment Stations and Administrator's Representatives of the Agricultural Research Service, USDA, of the Southern Region. Members of the task force were selected for expertise in vegetable research and the group included horticulturists, geneticists, plant pathologists, food scientists, agricultural engineers, entomologists, home economists, and agricultural economists. The purpose of the Southern Region Vegetable Task Force is to evaluate present research efforts and suggest changes in research programs to meet present and future needs.

The organizational meeting of the Southern Region Vegetable Task Force was held at Gainesville, Florida on June 14 and 15, 1973. Sixteen members attended the first meeting and additional scientists were proposed for membership. Doctors S. H. West and C. H. Harry Neufeld, administrative representatives, presented to the group the Task Force Guidelines prepared by Dr. Jay C. Murray. These guidelines were most useful in the preparation of this report. A membership list and officers elected at June 14, 1973 meeting follows.

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Table 1. Summary of Scientific-Man Year's (SMY's) for Vegetable Research in the Southern Region by Research Problem Areas (RPA's) for State and Federal Scientists.

RPA		Current[a]	No Increase[b]	10% Increase[c]	Recommended[d] [e]
204	Control of Insect Pests	20.9	27.2	30.0	44.0
205	Control of Diseases	40.5	42.5	43.2	48.2
206	Control of Weeds and Other Hazards	12.5	12.5	12.5	14.0
214	Protection of Vegetables from Pollution	0.2	0.2	0.2	1.0
304	Improvement of Biological Efficiency	69.7	49.2	53.5	56.4
305	Mechanization of Production	19.6	30.5	35.0	45.0
306	Production Management Systems	3.4	4.2	5.6	12.0
402	Production of Vegetables with Improved Consumer Acceptance	8.6	9.9	14.1	22.9
403	New and Improved Vegetable Products	21.3	19.8	21.6	23.0
404	Quality Maintenance in Marketing	9.3	10.0	11.0	21.0
501	Improved Grades and Standards	0.3	0.6	0.7	2.5
503	Marketing Efficiency of Agricultural Products	4.8	3.8	4.2	6.0
506	Supply Demand and Price	3.2	2.2	2.6	5.0
507	Competitive Interrelations in Agriculture	1.6	2.0	2.0	4.0
508	Domestic Market Development	0.9	0.9	1.0	2.0
509	Performance of Marketing Systems	5.4	5.4	5.4	8.0
601	Foreign Market Development	1.2	1.2	1.2	1.2
603	Technical Assistance for Developing Countries	0.0			
701	Toxic Residues in Food	2.4	1.8	1.8	1.9
702	Food Protection from Toxins	0.3	0.2	0.2	7.0
703	Food Consumption Habits	0.3	0.3	0.3	1.0
704	Home and Commercial Food Service	0.1	0.1	0.1	0.5
708	Human Nutrition	0.4	0.4	1.5	12.0
TOTAL		226.9	226.9	247.7	360.7

[a]/Current data from CRIS printout FY 1972

[b]/No Increase - no change in funds for Southern Region

[c]/10% Increase - 10% increase in funds for Southern Region

[d]/Recommended - Level within 10 years to provide solution to problems.

[e]/See additional data on SMY distribution by VRA and on production acreage in Appendix VI.

SOUTHERN REGION VEGETABLE TASK FORCE

Introduction

The format being followed in this report is similar to that suggested by the Southern Research Planning Committee. In the past, vegetable research results have contributed to the increased efficiency of vegetable production. The coordinated efforts of many research disciplines will be needed to advance the vegetable industry in the Southern Region during the next ten years. Combined research teams for a vegetable commodity might include horticulturists, engineers, plant pathologists, food scientists, entomologists, and economists.

This report is presented by research goals and problem areas that need solutions and it represents the best judgement of scientists knowledgeable in vegetable research. Identified research problems were assigned priority ratings from 1 through 4. A rating of 1 indicates the most critical problems while a rating of 4 indicates a problem is important but not urgent. To encourage team research by combining discipline research efforts, the planning of the Southern Region Vegetable Task Force was organized into five Vegetable Research Area (VRA) Committees. These committees and chairmen are:

Vegetable Research Area I - Variety Improvement.

Dr. E. V. Wann

Vegetable Research Area II - Crop Protection, Growth, Development and Management. Dr. D. A. Heqwood

Vegetable Research Area III - Harvesting, Handling and Marketing. Dr. Carter Price

Vegetable Research Area IV - Processing and Utilization.

Dr. J. L. Collins

Vegetable Research Area V - Nutritional and Organoleptic Quality and Regulatory Considerations.

Dr. J. F. Kelly

Table 1 presents a summary of the task force recommendations on distribution of research efforts. Table 2 gives the vegetable crop values in the Southern Region.

Situation

The vegetable industry in the Southern Region is extremely diverse. About 35 vegetable crops are grown commercially to supply a multitude of market demands for both a fresh-market and processing industry. The fresh-market industry is much more important in the Southern Region than the processing. The total farm value of fresh-market vegetables in the Southern Region approaches 525 million dollars annually, while the value of processing vegetables is about 60 million. These figures, however, do not include the value of many small acreages and home gardens, Table 2.

Compared to agronomic crops, vegetables directly involve a much larger segment of the population in the production phase. Vegetables are grown by many urban dwellers for enjoyment and to supplement their diets, by families on small farms to supplement their income, and by larger concerns as a major production enterprise.

In the U. S. there is a trend towards the consumption of more processed and less fresh vegetables. In 1949-51, the average per capita consumption of fresh and processed vegetables was 114.4 and 83.4 pounds, respectively. For the 1969-71 period, the figures were 99.0 and 114.4 pounds, a reversal. The projection is that this trend will continue and the differences will increase at a rapid rate.

Per capita incomes in the Southern Region have risen markedly in the past few years resulting in more spendable income that is being used for food-related purchases, including vegetables. The Southern Region can play a major role in vegetable production for regional, national and international consumption. It also has a vital role in producing fundamental scientific knowledge about vegetable crops and to develop production techniques that may be used domestically as well as exported. The funding of vegetable research in the future must reflect a different philosophy - that of researching ways to develop the potential of new crops while maintaining or increasing, if desirable, present acreages of crops already grown in the area. For example, production knowledge must be developed on processing crops not presently grown on a large acreage so that it can be used to induce the processors to develop their industry in this area. This is an investment, perhaps slightly speculative, but necessary, if the region is to realize its leadership potential. Future methods of funding vegetable research must reflect this approach.

Table 2
The value in thousands of dollars of major vegetable crops in major producing states in the Southern Region for 1971 as reported in USDA Agricultural Statistics - 1972. 1/

	ALA	ARK	FLA	GA	KY	LA	MISS	N.C.	OK	S.C.	TENN	TEX	VA	TOTAL
	Estimated value X 1,000													
BEETS												290		290
BROCCOLI												1037		1,037
CABBAGE			13819	1185		1124	203	3089		769	546	12619	1225	34,579
CANTALOUP			642	1294						1230		16353		19,519
CARROT												21030		21,030
CAULIFLOWER												546		546
CELERY			19751											19,751
CUCUMBER (FM)			12130					2518		2821		2625	2215	22,309
CUCUMBER (PROC)								7942		2107		2673	559	13,281
EGGPLANT			3014											3,014
ESCAROLE			7565											7,565
LETTUCE			3595					207				6750		10,552
ONION												20714		20,714
PEPPER (GR)			20131			1034		3944				8338	210	33,657
POTATO2/	7168	419	19270		739	473	553	6550			1677	15455	14410	66,714
SPINACH (FM)												2769	576	3,345
SPINACH (PROC)		605	259						570					1,434
SNAP BEAN (FM)	396		18492	1541		749		4096		1800	546		2628	30,221
SNAP BEAN (PROC)		899						296	423		2438	631	472	5,159
SWEET CORN	93		29391					2018				1858	1383	34,743
SWEET POTATO	2796	634		4707		12737	4750	16342		666	1426	5516	4009	53,583
TOMATO (FM)	4352	8712	82227	1297	1066	1949		4164		7200	2851	9107	3295	126,220
TOMATO (PROC)			971									1470	1362	3,803
WATERMELON	2629	1007	20441	4937		536	1122	1353	1970	3510		14564		52,069
TOTAL	17434	12276	251698	14934	1805	18602	6628	52519	2963	20103	9484	144345	32344	585,135

1/ Does not include many smaller production areas that may be significant within a state.

2/ Prices for potatoes are based on 1970 crop averages by state.

VEGETABLE RESEARCH AREA I

Variety Improvement

The success of vegetable production in the Southern Region will depend largely on the availability of improved varieties that are specifically adapted for the Southern Region and its various types of production. Fortunately, a great deal of work has already been done toward the development of improved varieties of most vegetable crops. Yet, for vegetables to remain competitive in a mechanized agricultural system, and to provide the consumer with high quality produce at a reasonable cost, much more research is needed in the area of variety development. Research should be continued and expanded to develop improved varieties for maximum yields, quality of the product, environmental adaptability, and with resistance to the prevalent diseases, insects, and nematodes.

There are currently 57.7 scientist-man-years (SMY) devoted to vegetable breeding in the Southern Region. In general, their distribution is in relation to the economic importance of the various crops grown in the Southern Region. Although some deficiencies were noted in certain areas where a crop has significant production and little or no research on variety development. Related to this topic, the committee wishes to point out what appears to be a serious deficiency in sub-professional and technical support for the present level of SMY's. We strongly recommend that high priority be given to providing the necessary technicians, laboratory and field helpers to adequately support research scientists who are presently engaged in variety development.

The contributions of commercial plant breeders must also be taken into consideration in the report. Some of the larger seed companies and vegetable processors have their own plant breeders who contribute significantly toward variety development in several vegetable crops. However, their efforts are usually in the final stages of the breeding process and generally result in finished cultivars for grower use. They generally are not equipped to engage in the basic studies necessary for early stages of germplasm development. It is in this area that State and Federal scientists can make the greatest contribution by developing basic breeding stocks and inbred lines to be used by commercial breeders. This does not preclude, however, the public supported breeder from doing the final breeding work and releasing a finished cultivar when it is expedient to do so. Active cooperation should be strongly encouraged between private and public breeders in order to obtain the greatest benefit from the total research effort.

In order to meet the growing demand for food in this country and to develop the potential of the Southern Region for vegetable production, research in the area of variety development will have to be substantially increased over its present level. The following varietal characteristics should be developed and incorporated in just about every vegetable crop

grown in the Southern Region:

a. Adaptation to environmental conditions of the Southern Region (RPA 204, 205, and 304).

b. Resistant to diseases, nematodes, and insects (RPA 204 and 205).

c. Adaptation to a mechanized system of production, including harvest (RPA 305).

d. Improved nutritional and aesthetic qualities (RPA 402).

e. Varieties especially adapted for home and market gardens (RPA 204, 205, 304, 305, and 402).

The VRA-I Committee recognizes also that a urgent need exists for the introduction and screening of new germplasm for use in vegetable breeding programs. Broad based genetic adaptation and resistance to pests should be developed where possible to minimize the genetic vulnerability to crop failure. This is not meant to de-emphasize mono-genic types of resistance, but to emphasize the need to develop alternate types that would be less susceptible to new biological races of plant pathogens. The Committee on Genetic Vulnerability of the Agricultural Board, Division of Biology and Agriculture, National Research Council, National Academy of Sciences, stated in their report (NAS Report, "Genetic Vulnerability of Major Crops", 1972) that vegetable industries in the U. S. were especially vulnerable to disease epidemics because of the need for high levels of uniformity plus the dependence on genetic control for many diseases. They also state that the displacement of old varieties by new uniform hybrids may be a serious loss of germplasm for future breeders. In view of this vulnerability, it seems extremely important that a wide diversity of germplasm be maintained for all vegetable crops and that new cultivars be developed with broad genetic bases whenever possible. The challenges of genetic vulnerability are appropriately described in Part III, Chapter 16, of the NAS Report. A subsequent report which deals with the management of plant genetic resources titled, "Recommended Actions and Policies for Minimizing the Genetic Vulnerability of Our Major Crops", November 1973, was prepared by an ad hoc subcommittee of the Agricultural Research Policy and Advisory Committee for the U. S. Department of Agriculture and the National Association of State Universities and Land Grant Colleges Cooperating. The subcommittee makes several recommendations that relate directly to the research objectives and approaches set forth by this Task Force.

Another urgent need that directly affects the success of variety development is that of a cooperative team effort. The development of a totally adapted variety will usually require the expertise and research efforts of Breeder, Horticulturist, Pathologist, Physiologist, Food Scientist, Chemist, Entomologist, Soil Scientist, and Engineer. This committee recommends that, in all future research planning, the team approach to problem solving be employed when applicable. Again, the

committee stresses the importance of adequate technical support and modern facilities to permit the efficient productivity of SMY's devoted to variety development. The committee recommends that no less than two full-time research technicians be employed for each SMY and that modern facilities be provided.

The location of additional SMY's on variety development should be determined by the areas, or potential areas, of production. A significant part of any breeding program must be the selection of genotypes having maximum adaptation to the environmental conditions under which they will be grown. Consequently, it will be essential that at least the final stages of varietal development be conducted in the production area.

Some of the more critical needs for improvement of major vegetable crops in the Southern Region are listed in Appendix 1.

VRA-I Research Goals

A. Breeding and Selecting Vegetables for Resistance to Insects

Research Problem Area	Priority (1-4)	Scientific Man Years (SMY)* Current	No Increase	10% Increase	Recommended
RPA 204	1	3.2	7.2	8.0	12.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation:

There is an urgent demand for more effective methods of insect control on vegetable crops in order to produce adequate amounts of high quality, uncontaminated food for the expanding population, and to do so without detriment to environmental quality. Insects cause an estimated $25 million annual loss on vegetable crops in the Southern Region of the United States by direct feeding, transmission of disease, and by contamination of the end product. Approximately one million acres of commercial vegetable crops are treated in the South with insecticides annually at an additional cost of about $25 million; not including the cost of insecticides used in home gardens. The use of insecticides is necessarily heavy in the Southern Region because the warm, humid climate is conducive to population buildup of insect species.

The shift from the use of the cheaper, more persistent chlorinated hydrocarbons to the use of low residual, highly toxic organophosphates has resulted in the need for more frequent applications of the more expensive chemicals. Along with the high costs of developing new insecticides (estimated to be as high as $2.5 million each) there are higher costs for monitoring the produce for toxic residues. Also, there are new and more stringent restrictions on the sale and use of insecticides on vegetable crops. Indications are that in the future chemical companies will develop and seek registration for only those insecticides for use on crops grown in large acreages, thus leaving many minor vegetable crops with no means of chemical insect control.

Heavy dependence upon the use of chemicals for insect control greatly increases the chance of developing resistance to the few available chemicals. It has been reported (Food and Agr. Organization, 1969) that over 200 species of insects are known to have developed resistance to one or more insecticides. Therefore, the development of host plant resistance to insects in vegetable crops should reduce the dependence on chemicals and ultimately reduce costs to the vegetable industry. Even partial resistance would reduce dosage rates and the frequency of spray applications. Genetic resistance is one of the most economical methods of insect control. It is persistent througout the season, and leads to a decrease in insect

populations. This concept has been successful for control of pea aphid on alfalfa, greenbug on barley, wheat and oats, hession fly and sawfly on wheat, and leafhopper and bollworm on cotton. Partial resistance has been discovered in vegetable crops for several important insect pests, yet there are very few insect-resistant cultivars available for commercial production.

Objectives and/or Research Approaches:

To reduce direct and indirect losses to vegetable crops caused by insects, and to reduce the need for frequent chemical applications to control harmful insects, the following research approaches are recommended:

1. Collect, screen, and evaluate all available germplasm for sources of resistance to insect pests.

2. Determine the bases for resistance, whether physical or chemical.

3. Determine the heritability and breeding behavior of resistance factors.

4. Incorporate the resistance into improved breeding stocks and commercially acceptable cultivars through appropriate breeding procedures.

B. Breeding and Selecting Vegetables for Resistance to Diseases

Research Problem Area	Priority (1-4)	Scientific Man Years (SMY)* Current	No Increase	10% Increase	Recommended
RPA 205	1	16.2	18.2	18.2	22.2

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation:

Disease resistance is one of the most critical factors associated with production stability of vegetable crops in the Southern Region. Numerous varieties have been developed with resistance to one or several prevalent diseases, yet practically every vegetable crop is grown as a high risk crop because of susceptibility to one or more diseases. Existing resistance must be transferred to new varieties adapted for mechanization, etc. The effectiveness of resistant varieties has frequently been reduced because of pathogenic race developments. We critically need new sources of resistance and methods of utilizing and managing genes so as to control the serious diseases and avoid genetic vulnerability in all vegetable crops.

Objectives and/or Research Approaches:

In order to find sources of resistance to the serious diseases of vegetable crops and to incorporate them into new varieties and hybrids with superior horticultural characteristics, the following research approaches are recommended:

1. Develop new techniques for disease resistance screening.
2. Find new sources of resistance.
3. Develop more efficient methods for breeding varieties with broad based field resistance to multiple diseases.
4. Investigate pathogen genetics and population dynamics as influenced by utilization of various types of host resistance genetics.
5. Develop more efficient methods for detecting low level field resistance in various sources and bringing together into polygenic systems with high level resistance.
6. Develop gene management methods which reduce vulnerability of resistance based on single genes.
7. Evaluate multiline varieties and other systems of deploying genetic diversity as a tool in promoting pathogen management and varietal stability.

8. Evaluate and analyze field resistance to multiple diseases which theoretically exists to varying degrees in presently grown varieties.

9. Develop new methods for utilizing resistance genetics in interspecific, intergeneric or wider crosses, including direct DNA transfer.

10. Investigate host-pathogen relationships in susceptible and resistant genotypes relative to nature of resistance in polygenic and simply inherited systems.

11. Investigate new systems of varietal development that emphasize genetic diversity for biologically sensitive genetics while maintaining acceptable uniformity for product related genetics.

12. Investigate cytoplasmic components that condition disease resistance and techniques for systematic utilization.

13. Investigate biological, physical and chemical aspects of long storage and perpetuation of diverse vegetable germplasm so as to be readily available to the scientific community.

C. Improvement of Biological Efficiency in Vegetable Crops

Research Problem Area	Priority (1-4)	Scientific Man Years (SMY)*			
		Current	No Increase	10% Increase	Recommended
RPA 304	3	29.4	14.4	14.4	14.4

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation:

Vegetable cultivars capable of producing stable, economical yields in the Southern Region must be adapted to a fairly wide range of soil types and environmental conditions. Maximum adaptation generally results from the assimilation of many coadaptive genes which provide a buffering capacity to adverse environmental conditions, efficient utilization of light, water and nutrients, and resistance to common pests. Since vegetable crops are usually grown on high-value land and require high capital and labor input per unit of production, the greatest possible biological efficiency needs to be developed in the basic unit of production; the plant. Plant characters such as feeder root systems, leaf area, photosynthetic efficiency, heat and cold tolerance, resistance to diseases, insects and physiological disorders contribute to the overall efficiency of the plant. Attempts to improve the efficiency of the individual characters through breeding will involve expertise in many disciplines as well as a great deal of basic and applied research. The physiological processes essential to plant growth and reproduction and the genotype-environmental interactions will have to be explored. Finally, parameters must be developed that will measure the best genetic expression of each adaptive character and their combined potential for greatest productivity under modern production practices in the Southern Region.

Objectives and/or Research Approaches:

To improve the efficiency of the basic biological unit of production and to develop vegetable cultivars with maximum adaptation for the Southern Region, the following research approaches are recommended:

1. Collect and maintain germplasm of all vegetable crop species that may contribute genetic material to breeding programs.

2. Develop more effective breeding procedures to deal with multiple quantitatively inherited characters.

3. Investigate genotype-environment interactions and select gene combinations that show the greatest buffering capacity to adverse environmental conditions.

4. Develop and perpetuate cooperative trials to evaluate the range of breeding-line adaptation and their tolerance to environmental hazards.

5. Investigate the biological mechanisms for nutrient absorption and translocation and select genotypes that are most efficient in these processes.

6. Determine the areas of genetic control over photosynthetic efficiency and select the most efficient genotypes.

7. Identify plant types and specific characters that lend to overall efficiency under a mechanized system of production.

D. Breeding and Selecting Vegetables for Mechanization of Production

Research Problem Area	Priority (1-4)	Scientific Man Years (SMY)*			
		Current	No Increase	10% Increase	Recommended
RPA 305	2	5.0	14.0	16.0	20.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation:

Most agronomic crops such as corn, soybeans, cotton, peanuts, small grains, etc. have been adapted to systems of mechanization. The systems include most phases of planting, harvesting, handling and processing. The development of these crops for mechanization has been more rapid than with vegetable crops, mainly due to the physical structure of the edible portion of the plant. Whereas, agronomic crops are generally mature and quite durable with respect to physical handling and storage, vegetables are generally immature, easily damaged and have a relative short storage life. Vegetables customarily require high inputs of hand labor starting with seeding or transplanting through harvest and post-harvest handling. Because of the growing shortage of hand labor in this country and concomitant sociological problems associated with migrant field workers, the heavy dependence upon hand labor for vegetable production must be eliminated. Therefore, if vegetables are to remain competitive with other crops in our mechanized agricultural system, and if we are to provide the consumer with a high quality product at a reasonable cost, we must achieve with vegetables an efficient mechanized system of production.

Objectives and/or Research Approaches:

In order to increase production efficiency, reduce costs and labor requirements, and to make vegetable crops more competitive with agronomic crops for land use, the following research approaches to variety improvement are recommended:

1. Develop cultivars with plant types that lend themselves to efficient mechanical harvest under field conditions.

2. Develop cultivars that have concentrated yields and uniform maturity for maximum single-harvest yields.

3. Develop cultivars with predictable growth and maturity rates to make programmable production possible.

4. Develop cultivars that have more accessible and more durable fruit to facilitate mechanical handling.

5. Develop cultivars that are adapted for direct seeding and having the ability to establish uniform seedling stands under adverse field conditions.

E. Breeding and Selecting Vegetables for Improved Quality Characteristics

Research Problem Area	Priority (1-4)	Scientific Man Years (SMY)* Current	No Increase	10% Increase	Recommended
RPA 402	3	3.9	3.9	6.9	10.9

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation:

A knowledge of the relationship of genetic, nutritional, physiological, and biochemical factors that affect quality in vegetable crops is imperative for successful breeding programs. Some progress has been made toward achieving objectivity in measuring quality components. However, standardization of improved methods and better techniques for rapid and accurate sampling under laboratory and field conditions are needed. Research is needed on non-destructive methods for measuring quality components and equating them with consumer acceptance. Also, it may be required in the future that breeders monitor certain nutritional and toxicant components in varieties they develop in order to meet the requirements of FDA for GRAS listing of new cultivars. Certainly breeders must be aware of the nutritional level in breeding materials and any potentially dangerous toxic components they possess.

Objectives and/or Research Approaches:

To develop objective techniques for identifying and measuring quality components; to investigate the genetic influence on quality; and ultimately to improve the nutritional and other quality attributes of vegetables, the following research approaches are recommended:

1. Establish germplasm collections of known quality composition for use in breeding programs.

2. Investigate genetic factors that affect specific chemical components in vegetables and find ways to exploit useful genes for quality improvement.

3. Study the heritability of known toxicants in vegetables and identify germplasm with low concentrations of harmful compounds.

4. Develop objective methods for measuring quality components and correlate these with consumer acceptance to increase the efficiency of breeding procedures.

APPENDIX I

VRA-I. Specific needs identified for the more important vegetable crops produced in the Southern Region

SNAP BEAN:
1. Resistance to diseases, especially the root-rot complex.
2. Yield and quality improvement in bush types.
3. Adaptation of varieties for specific geographic areas, production systems, market demands, and different seasons.

CANTALOUPE:
1. Resistance to gummy stem blight, downy and powdery mildew, anthracnose, alternaria, bacterial wilt, and virus diseases.
2. Resistance to insects attacking the seedlings and fruit.
3. Improved eating and nutritional qualities.
4. Dwarf or semi-dwarf varieties that yield well and are adapted for mechanical harvest.

CARROTS:
1. Develop lines suited for hybrid seed production.
2. Resistance to diseases, especially Alternaria.
3. Strong foliage and uniform maturity to aid in machine harvesting.
4. Improved color and flavor.

COLE CROPS:
1. Adaptation for mechanical harvesting.
2. Increased yield potential.
3. Resistance to black leg, downy mildew, fusarium, and black rot.
4. Resistance to cabbage loopers and imported cabbage worm.

CUCUMBERS:
1. Adaptation for mechanical harvesting.
2. Increased yield for mechanical harvestable types.
3. Improved brining quality.
4. Disease and insect resistance.

LETTUCE:
1. Better adaptation to climatic conditions of the Southern Region.
2. Resistance to virus diseases, tip burn, and downy mildew.
3. Varieties that mature uniformly and that can be mechanically harvested.

OKRA:
1. Develop varieties adapted for mechanical harvest.
2. Increased yield potential.
3. Improved pod quality.
4. Resistance to nematodes, Fusarium wilt, damping-off, and root rot.

ONION:
1. Resistance to downy mildew, purple blotch, pink root, tip burn, botrytis, Fusarium, bulb rot, and neck rot.
2. New varieties with predictable maturity dates to permit programmable production.
3. Increased storage life.

PEA, SOUTHERN:
1. Resistance to insects, particularly the cowpea curculio and stinkbug.
2. Resistance to virus diseases.
3. Develop varieties with improved yield potential and suited for once-over machine harvest for canning and freezing.

PEPPER:
1. Resistance to bacterial leaf spot, fruit rots and virus diseases.
2. Resistance to corn borer.
3. Varieties suited for mechanical harvest.

POTATO:
1. Develop varieties specifically adapted for production in the Southern Region with emphasis on both fresh market and processing types.
2. Resistance to prevalent diseases.
3. Improved yield and seed production capability.

SOYBEAN, EDIBLE:
1. Develop strains with improved flavor and adaptation to the Southern Region.
   NOTE: This crop has excellent potential as a major food crop in the Southern Region.

SPINACH:
1. Resistance to white rust, Cercospora leaf spot, and anthracnose.
2. Resistance to aphids.
3. Improved adaptation for production in the Southern Region.
4. Improved quality for canning and freezing.

SWEET CORN:

1. Resistance to the corn earworm.
2. Genotypes that have improved quality and quality maintenance properties for fresh market.
3. Incorporate new genes to improve protein quality for human consumption.
4. Resistance to virus diseases, northern and southern corn leaf blight.

SWEET POTATO:

1. Resistance to diseases, especially soil rot, scurf, black rot, soft rot, Fusarium wilt and surface rot. These diseases may cause losses both in the field and in storage.
2. Resistance to soil insects and the sweet potato weevil.
3. Develop varieties suited for mechanized planting and harvest.
4. Improved root quality for processing.

TOMATO:

1. Develop varieties suited for processing and the fresh market and adapted for once-over machine harvest.
2. Resistance to foliage and fruit diseases, insects and nematodes.
3. Develop varieties with ability to set fruit during periods of high temperature.

WATERMELON:

1. Resistance to gummy blight, Cercospora leaf spot, Anthracnose, and Fusarium wilt.
2. Develop types of melons that can be harvested and handled mechanically.
3. Develop genetic markers in tetraploid lines and procedures for seedless watermelon seed production.

VEGETABLE RESEARCH AREA II

Crop Protection Growth, Development and Management

The rapidly increasing demands for vegetable products, coupled with increasing costs and decreasing resources of production, have created a critical need for more efficient, economical means of production. Such factors as the increasing land costs that result from encroachment for residential areas, highways, airports and other uses, a continually decreasing labor supply coupled with high labor costs, the cost of other resources such as seed, chemicals, fertilizer, and equipment, and an apparent decreasing fuel supply, have heightened this need seriously. For example, growers spend millions of dollars annually for pesticides, labor, operation, and depreciation of machinery to achieve partial control of crop pests. Even so, diseases reduce yields about 10% annually. The present situation, therefore, strongly emphasizes the need for a more modern, effective approach to production because the region has the land area, basic soil fertility, water transportation, and climate to become a leader in U. S. vegetable production. The use of research to develop production techniques, can be even more successful and productive if it is closely coordinated on a regional basis.

The present and forseeable situations demand the development of a system concept of production management for individual crops, or groups of closely related crops, that can be produced following a single system of management. Such a system, which could be described as an intensified production program in which recommended cultural practices and innovations are integrated in such a way that maximum yields of optimum quality are produced, provides checks and balances to insure that the best job possible is being done to grow the crop successfully. It also provides flexibility for the adoption of changes that are brought about through research.

Our present state of knowledge is inadequate for the development of a completely effective management system that would exploit the true (maximum) genetic potential of vegetable crops. Research must be developed to solve the problems that now limit significant increases in yield. These problems can be identified as falling into four general categories. They are:

(1) Inadequate plant protection from planting through harvest

(2) A lack of knowledge that could identify and characterize plant responses to various cultural practices under intensified production systems as well as crop requirements for fertilizer and moisture

(3) Failure of present cultivars to possess plant development characteristics suited to intensified production systems and

(4) The use of undesirable but necessary individual production practices that limit yields and/or lower quality.

It was estimated in 1969 that approximately 5 million acres of vegetable crops in the U. S. are treated annually with chemical insecticides at a cost of about $125 million, although at that time, insects caused an estimated annual loss of $253 million. Development of acceptable chemical control measures has since been complicated by more stringent requirements intended to reduce potential residue hazards to the consumer, to beneficial insects, and to other non-target organisms in the environment. The recent transition to increased dependence on non-persistent chemicals has often required more frequent applications of more toxic chemicals than in the past. Cancellation of old registrations and the high cost of new registrations have combined to reduce the number of legal treatments to crisis level for some crops. Resistance of insects to new insecticides has been observed within 3-5 years. It is therefore essential that alternate methods of insect suppression be developed for use in integrated systems of pest control; these include attractants, repellants, cultural controls, pathogens, parasites, predators, host plant resistance, and selective, low-residue insecticides. Progress in vegetables has been relatively slow because most crops support a unique complex of pests, economic thresholds of key species often approach zero, and most investigators are responsible for several crops, thus precluding intensive studies on any one crop.

It is felt that the southern region is now at a turning point in vegetable production. This is the time to strengthen our scientific manpower to supply the knowledge necessary to allow this region to realize its production potential and assume its role of leadership nation-wide in vegetable production.

Administrative support for vegetable crop research must reflect strong increases in financial support and show realistic faith and optimism in the future by a willingness to fund research designed to produce the knowledge necessary to the development of the vegetable production potential of the region. Without a strongly supported, progressive region-wide program our present efforts will shortly be ineffective. The development of a regional program with each state entity within the region contributing to that area in which it is peculiarly fitted should do much to eliminate unnecessary duplication. The committee suggests that duplication is not necessarily bad, in fact that there are many instances in which controlled duplication is desirable or even necessary; however, there is undoubtedly duplication that is excessive and wasteful of time and money. Therefore, it is felt that at some point in the future consideration should be given to developing, funding, and executing research programs on a production area basis.

The committee for VRA-II, through the cooperation and assistance of key scientists throughout the Southern Region have identified 12 major subareas of crop management, culture, and plant development where our present state of knowledge is seriously inadequate for one or more vegetable crops. The recommended research and scientific man year requirements are discussed under appropriate Research Problem areas identified in Table 1 of the Task Force Report. The identity of each sub area and the priority levels for scientific manpower needs for individual crops have been set

forth in Table 1 of the appendix. Research in the areas identified according to the priorities assigned will, in the committee's opinion, provide the knowledge necessary to develop production management systems for vegetable production. Committee members share a strong belief that the management system concept will be necessary for profitable, successful vegetable production in the Southern Region.

VRA-II Research Goals

A. Control of Insect Pest of Vegetables

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA 204A	1	6.5	8.0	8.0	16.0
RPA 204B	1	2.9	2.4	2.4	2.0
RPA 204C	1	11.5	10.5	11.3	34.0

*SMY shifts based on total funds for Southern Region vegetable research.

RPA-204A Insecticidal Methods of Controlling Vegetable Insect Pests.

Situation Evaluation: Chemical control procedures are currently the first line of defense against most vegetable pests. In most cases, it remains the only prospect for the near future. The high per-acre value of vegetable crops and intensive population pressure by many key pest species often necessitates frequent and heavy applications of insecticide (up to 20 applications per season on sweet corn). Nonpersistent chemicals are available for most crops, but most of them are nonselective, being highly toxic to beneficial insects and other non-target organisms. They are therefore incompatible in an integrated program with several non-chemical methods of control. With the exception of new registrations for use on cabbage, tomatoes, potatoes, and sweetcorn, the public can expect little help from private industry. Registrations for use on most vegetables will have to be developed from chemicals that are registered by industry on major crops - primarily cotton, corn, and soybeans. Public agencies can expect to bear more of the burden for efficacy trials and residue data, and the IR-4 committee will become increasingly important in obtaining new registrations on vegetables. An increase in RPA 701 is recommended in support of these requirements.

Objectives and/or Research Approaches: Development of cheaper and more effective insecticidal control methods that will leave no objectionable residues, destroy few if any beneficial insects, and probably no hazard for higher animals. Recommended approaches are:

A. Screening of new insecticides as they become available to find safer, more effective, and selective chemicals.

B. Determination of the residues left on vegetable crops at the time of harvest.

C. Evaluation of the side effects of effective insecticides.

D. Evaluation of new insecticide formulations, rate and timing of applications, and various types of application equipment, to provide more effective control of target insects and prevent drift of insecticides from target areas.

E. Integration of insecticides with other measures such as chemical attractants, light traps, use of pathogens, parasites, predators, or bio-environmental controls to produce more economical control systems with reduced hazards.

RPA-204B Biology of Insects Attacking Vegetable Crops.

Situation Evaluation: The breakthroughs which have provided more effective control of insect pests by nonchemical or integrated methods have resulted from new insights gained through additional detailed knowledge of biology and ecology of the target species. Studies of mating habits have revealed the presence of sex attractants; detailed ecological studies have provided information on overwintering ability and overwintering habitat, parasites, predators, and diseases. Such studies, when conducted, have revealed susceptible stages of the life cycle, alternate methods of control and more effective timing of controls. Such detailed information is not available on most of our vegetable pest species.

Objectives and/or Research Approaches: Gathering background information on the occurrence, distribution, ecology, life history, host range, and physiology necessary to develop new methods of control or make existing controls more effective. Recommended approaches are:

A. Establishment of the occurrence, distribution, and abundance of the target species and develop accurate methods of measuring population density.

B. Determination of the seasonal life history, including host-plant sequence, migration, susceptibility to biotic agents, mating habits, reproductive potential, and overwintering habits.

C. Establishment of the economic effect of a population on the host crop and the threshold below which the insect can be tolerated.

D. Determination of the effect of cultural practices on abundance of the pest species.

RPA-204C Noninsecticidal and Integrated Methods of Controlling Insects on Vegetable Crops.

Situation Evaluation: Pilot projects on other crops have demonstrated the efficacy of nonchemical controls such as the use of attractants, predators, pathogens, host plant resistance, sterility techniques, and modification of the environment. The integration of one or more non-chemical controls

with selective chemical controls appears highly promising. In some crops like cabbage, tomatoes, sweet corn, and root or tuber crops, it is essential to develop noninsecticidal methods in order to relax the high requirements that are now demended of chemical insecticides. The methods that require the least management (for example, host plant resistance or pathogens) should receive highest priority. Resistance research should be coordinated with VRA 1.

Objectives and/or Research Approaches: To reduce direct and indirect damage to vegetables through use of physical or chemical attractants or repellants; to develop crop varieties resistant or tolerant to insects; to determine the effectiveness of parasites, predators, and pathogens; to devise methods for culturing, dispersing, and enhancing the effectiveness of biotic agents; to determine if environmental modification, including the changing of cultural practices, will reduce pest species; to integrate successful techniques, with judicious use of insecticides where applicable; and to use area-wide autocidal techniques when applicable. Recommended approaches are:

A. Identification of pathogens for control of vegetable pests; determination of biological and environmental factors that influence infection in the field, and of the pathogen's potential for mass culture and standardization in terms of virulence for practical application.

B. Collection and evaluation of germplasm for insect resistance. Incorporation of resistance in adapted varieties.

C. Identification of the parasites and predators within the pest population; determination of the extent of control exerted by these parasites and predators and the environmental conditions which favor such control; determination as to whether supplementing the natural population through sustained releases of laboratory-reared predators and parasites provides better control of pest insects; development of methods for mass breeding of parasites and predators.

D. Isolation of sex or feeding attractants; determination as to whether insects will successfully compete with natural attractants in the environment; combination of electromagnetic traps and other methods to attain a degree of population suppression.

E. Ecological studies, to determine possible weak links in the biology of pest species that would render them vulnerable to area-wide suppression by bio-environmental control measures such as removal of alternate host plants.

F. Testing to determine if major vegetable insect pest species can be sterilized by gamma irradiation, or with chemicals; development of mass rearing technology; determination as to use of such techniques in area-wide suppression programs.

G. Combine promising techniques into integrated systems of control suitable for use by commercial growers.

B. Control of Diseases of Vegetables

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA 205	2	24.3	24.3	25.0	26.0

*SMY shifts based on total funds for Southern Region vegetable research.

RPA 205A Nature of Diseases

Situation Evaluation: As many as fifty or more diseases are described in the literature as occurring on vegetables. A thorough understanding of the life history of the causal agent is necessary in order to attack the pathogen at its most vulnerable point to allow the researcher to direct the more intelligent selection, timing and application of control practices that will increase efficiency and reduce cost of production.

Objectives and/or Research Approaches: Establish the pathogenicity, host range, and life history of vegetable pathogens.

A. Identify, describe, and determine the host range of pathogens, and determine the environmental factors which favor their development.

B. Establish the life history of pathogens.

C. Study the epidemiology of Diseases to allow for more timely application of pesticides.

D. Study the interrelationships of two or more pathogens which occur on the same host at the same time.

RPA 205B Crop Sequences, management practices and other non-chemical control methods to reduce the incidence and severity of diseases.

Situation Evaluation: Crop rotation, tillage practices, and sanitation can effectively reduce the incidence and severity of many diseases. Some damping-off and root rot organisms can be reduced by plowing under dried straw or removing crop debris before planting the crop. Flooding during the summer months can destroy resting bodies of some fungi and eggs of nematodes. Eradication of certain weeds which act as virus reservoirs before the crop is planted can successfully control several virus diseases. Use of certified or indexed seed free of disease will substantially reduce the amount of primary inoculum present at the time of planting.

Objectives and/or Research Approaches: Study disease development under different biological, cultural, and nonchemical control methods, and develop the most effective disease control recommendations.

A. Study the pattern of disease development under different crop sequences as a potential means of disease control.

B. Determine the alternate crops and weeds which may serve as reservoirs of disease.

C. Study the effect of various cultural practices and biological methods on microorganisms in the soil.

D. Study other nonchemical control methods such as hot water, flooding, dry heat, deep plowing and seed indexing to reduce or eliminate the pathogen.

RPA 205C Chemical Methods of Controlling Diseases

Situation Evaluation: Vegetable growers use large quantities of chemicals to control plant diseases. Some chemicals are ineffective and too expensive to apply while others are more effective if applied properly, used in combination with another chemical or enhanced with the use of spreader-stickers. Continued work toward safer, more effective and economical pesticides is urgently needed.

Objectives and/or Research Approaches: Develop safer, more effective and economical chemicals with minimum residues for disease control.

A. Evaluate new chemicals for disease control based on laboratory and field testing.

B. Investigate new formulations, rates, spray intervals, combinations and spray patterns to achieve maximum benefit.

C. Search for new methods of application and equipment to reduce the amount of drift in the environment.

D. Investigate the use of disease forecasting so that the number of sprays can effectively be reduced.

RPA 205D Role of Insects in Transmission of Disease.

Situation Evaluation: Plant diseases vectored by insects are a serious problem for many vegetable crops. The role of insects in the epidemiology of diseases must be thoroughly investigated so that control measures can be developed. When insecticides prove to be ineffective as in the case of stylet-borne virus diseases, alternative methods such as repellents, oil sprays, and antiviral agents should be evaluated.

Objectives and/or Research Approaches: Identify the insects transmitting diseases, their method of transmission and develop measures aimed at disease control.

A. Establish through transmission studies which insects are involved and their mode of transmission.

B. Determine if the pathogen can multiply within the vector.

C. Through epidemiological and trapping studies, determine the time and pattern of disease spread and the effectiveness of chemical control.

D. Evaluate new means of control including biological controls, repellents, antiviral sprays and pheromones which may impede disease transmission.

RPA 205E Identification and Control of Foreign Diseases That May Damage Vegetables

Situation Evaluation: Many fresh vegetables are imported annually from foreign countries. This trend will increase substantially with growing harvesting costs and labor shortages here in the United States. The likelihood of importing foreign diseases and insects is therefore greater.

Prior knowledge as to a pathogens or organisms life history, host range, possible resistance and methods of control could prevent losses running into the millions of dollars annually.

Objectives and/or Research Approaches: Determine the potential damage that foreign pests could inflict on U. S. grown vegetables and develop methods to exclude or combat them.

A. Through cooperative efforts determine how well U. S. vegetable varieties can survive disease epidemics in foreign countries.

B. Establish methods of identification and means to exclude foreign pathogens and pests.

C. Initiate foreign based breeding problems to develop resistance to those diseases most likely to be imported.

D. Study the etiology of potentially dangerous foreign diseases.

C. Control of Weeds and Other Hazards to Vegetable Crops

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA 206	2	12.5	12.5	12.5	14.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The increasing scarcity of farm labor and its increasing costs are forcing the abandonment of hand weed control and creating a critical need for weed control systems requiring low labor inputs.

The advancing mechanization of vegetable production including harvesting, and the increasing degree of sophistication of farm equipment is creating additional pressure for weed control systems that assure weed free yields throughout the growing period to facilitate efficient operation of equipment.

The pressure for more efficient use of land by producing higher yields on smaller acreages has created a serious need for weed control systems that permit cropping sequences that utilize land to its fullest capacity.

More recent advancements in weed-control research has shown that in certain crops herbicides can significantly alter their chemical composition. This consideration must now become an integral part of regional research programs on weed control with chemicals.

Objectives and/or Research Approaches:

A. The development of weed control systems for specific vegetable crops through integration of systems for specific situations by:

   1. Determination of the most effective herbicide or combination of herbicides for safe use.

   2. Evaluation of mulches, tillage and other cultural practices as alternatives or supplements to chemical weed control systems.

   3. Evaluation of cropping sequences and systems relative to their effect on weed control measures.

B. The development of control measures for specific weeds by:

   1. Study of life cycles, physiology and dormancy of harmful weed species.

2. Determination of most effective timing and placement of herbicides for maximum control of specific weeds.

C. Determination of behavior and action of herbicides in plants and soils to assist in developing control measures and improved application techniques by:

1. Identification of site and mode of herbicide penetration, absorption, translocation, and biochemical pathway disruption in plants for various herbicides.

2. Study of the behavior of herbicides in soils.

3. Study of the effects of herbicides on chemical composition of food plants.

D. Alleviation of damage to vegetable crops by weather, birds and other hazards by:

1. Development of methods for minimizing hail and frost injury.

2. Development of more effective control measures for birds.

D. Protection of Vegetables from Pollution

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA 214	3	0.2	0.2	0.2	1.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Atmospheric pollution is a serious, growing problem for plants, especially in highly populated areas where industry and automobiles are heavily concentrated. Due to the rapid population growth in the Southern Region, the high population centers therein can logically be expected to contribute significantly to plant injury by pollutants.

Commercial crops of spinach have been lost in California and photochemical injury has confirmed on beans, onions, tomatoes, squash, cantaloups, sweet corn, swiss chard, and eggplant. Each of these crops is commercially important in the Southern Region.

Objectives and/or Research Approaches: Determine the effects of various atmospheric pollutants on the growth, development, and yield of vegetables and develop methods for reducing their effects on production.

E. Improvement of Biological Efficiency of Vegetables

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA 304A	2	10.5	9.5	11.0	12
RPA 304B	2	29.8	25.3	28.1	30

*SMY shifts based on total funds for Southern Region vegetable research.

RPA 304A The Physiological Mechanisms and Processes Affecting Biological Efficiency

Situation Evaluation: Increased mechanization demands more uniformly growing crops--a process that begins with water imbibition by the seed but may be influenced by the conditions under which it was grown. Vegetable crop failure is often closely associated with poor seed quality and failure to germinate and grow properly. The need for information on seed metabolism during germination and seedling establishment and the influence of soil conditions, including fertility levels, is critical. The factors involved must be identified and controlled if possible.

A better understanding of the physiological response of the whole plant is essential if the complete genetic potential of the plant is to be realized. The identification of the organic acids involved and the delineation of their role in metabolism is especially important in bud initiation, development, flowering, proximal dominance, etc. Chemical regulators (synthetic hormones) should be explored for their usefulness as tools in vegetable research and production. New pesticides that are less toxic to man and the environment may be closely related to several of the synthetic plant growth regulators and may have a profound effect on the plant's physiological response.

Objectives and/or Research Approaches:

(1) Study the inter-relationships between the environmental factors in seed production and storage and seed size, germination, seedling vigor and crop growth and development. Such a study would include seed production and storage under controlled and recorded environmental conditions and subsequent germination and growth under carefully studied conditions for a complete life cycle.

(2) Study the effects of environmental and storage conditions during the production of propagating material on the number of plants produced, their vigor, and growth and development of the subsequent crop in vegetable

propagated crops. Propagating stock must be produced under carefully controlled environmental variables and these variables then related to plant production and subsequent crop growth under controlled conditions.

(3) Study the effects of plant growth substances and pesticides on flowering, fruit set and development and yield, quality and composition of such crops as tomatoes, cucurbits, legumes, okra and peppers. Of special interest in this area is the concentration of fruit set and maturity. This type of study would involve plant treatment and, following treatment, a study of the plants respiration, metabolism and further growth and development.

RPA 304B Improvement of the Management and Culture of Vegetables

Situation Evaluation: The singular and interrelated effects of environmental and physiological factors on fruit set and development are not completely understood. Understanding the relationship between the rate of fruit development, stage of maturity, and ovule development, would improve the accuracy of maturity prediction and reduce the risk of crop loss. Futher, more effort should be directed toward understanding the interactions among conventional production practices as fertilization, irrigation, mulches and crop yield and quality. Increasing mechanization and accelerated production costs, have re-emphasized the necessity for lower per unit production costs.

The several production factors that limit the development of production management systems can be summarized as follows: (1) physiological disorders resulting from improper nutrient levels, (2) the incompleteness of the minimum - till concept, and (3) high plant population effects on plant morphology and nutrient and moisture requirements.

Solutions to the above problems could increase vegetable production in the southern U. S. by as much as 50 percent or more with no increase in acreage planted and only a slight increase in cost of production.

Objectives and/or Research Approaches:

(1) To determine the plant population, macro- and micro-nutrient and moisture level conducive to the maximum yield per unit of area at the lowest per unit cost. The crops must be grown at various populations and under variable macro- and micro-nutrient and moisture levels and the yields determined. Then the lowest cost per unit must ascertained because maximum yield and lowest per unit cost are not necessarily synonymous.

(2) To determine the effect of the environmental variables such as soil type, soil preparation, nutrient level and source, and moisture level on the quality of vegetable products. Vegetables grown on various soil types and under varied nutrient levels and sources and varied moisture levels will be studied for nature and frequency of any physiological disorders and variations of nutritive value due to production variables.

(3) Study the effect(s) of time of planting and different cultural variables on the effectiveness of pest control measures. Crops such as green beans, leafy greens, etc. might be planted at specific intervals. The effect of cultural regime and planting date on the pest control measures required will be determined.

F. Mechanization of Vegetable Production

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA 305	2	3.0	5.0	6.0	8.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Unlike most field crops, the majority of vegetable crops are not highly mechanized. Vegetable crops generally require more numerous operations during seeding and growing periods than do field crops and their harvesting, with few exceptions, is almost entirely by hand methods. If the Southern Region's vegetable industry is to expand and offer producers attractive opportunities and, at the same time, meet the needs of society in providing an adequate source of high quality vegetables, new mechanized production and harvesting techniques must be reached and commercially developed. This is particularly true if present trends in social attitudes and economic conditions associated with hand labor continue.

Within any specific commodity (or a group of similar crops) production problems including land preparation, seeding/transplanting, cultivation, chemical applications, and plant environmental modification through moisture/temperature control (to the extent possible) will be considered in the context of its effects on biological efficiency and mechanization of the harvest operation. Once specific problems are identified then engineering solutions may be researched and synthesized.

As an example of this process, consider the soil profile requirements that mechanical harvesters may impose on low growing crops. For hand harvesting, the uniformity and height of beds may have little or no effect on biological efficiency - in fact beds may not exist. However, for operation of mechanical equipment during the harvesting operation, the height (or lack of height), profile, and variations in height and profile measured down the row may determine the success or failure of a particular machine. The problem then becomes one of being able to build a machine capable of compensating for "variations" or building a field without the variations being present. The latter choice is often desirable and may provide secondary benefits to the biological system. Bed forming, precision seeding and cultivation techniques can be engineered to provide row profiles to specification. Benefits to the biological efficiency may also provide a measure of moisture control not possible with conventional techniques - the end result being a crop grown under conditions conducive to mechanical harvesting.

Objectives and/or Research Approaches:

1. Delineation of production problems associated with crops of commercial importance (or potential importance) that are amenable to engineering solutions.

2. Development of solutions to meet the needs of the biological system and, at the same time, be compatible with mechanical harvesting operations that may exist or be developed.

G. Production Management System for Vegetables

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA 306	2	1.4	2.0	3.0	6.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The adoption of efficient, productive, production management systems requires that growers choose among many alternatives in the selection of crops, cultivars, planting time, row spacings, irrigation, disease, insect and weed control practices, and time and method of distribution and marketing. The proper selection from these alternatives should provide for optimum use of labor, capital, and machine capacity, as influenced by weather probabilities, field conditions, and time. Mathematical models needed for simulation of variables and alternatives in production systems will permit comparison of the profitability of various alternatives.

In the past, laborious methods of analysis often hindered the development of the system concept of production management and severely limited the number of comparable alternatives. High-speed computers and new analytical models have now opened the way to more comprehensive analyses of the relevant alternatives in crop production.

Objectives and/or Research Approaches: Determination of production practices, equipment adaptation, capital investments, and labor availability towards optimum income from vegetable production on individual farms by:

A. Adaptation and/or development and use of mathematical models for simulating different vegetable production systems, to identify those factors that require additional research.

B. Tests of hypothetical systems, towards utilization of all known resources of maximum yields. Simulated differences in crops, varieties, nutrients, water herbicides, and other elements of management will be compared, to determine the most productive and economical combinations.

H. Production of Fruit and Vegetable Crops With Improved Consumer Acceptance

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA 402	2	0.4	1.0	2.0	3.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The rapidly increasing mechanization of vegetable production and the advancement toward more itensified production systems can create problems in maintaining product quality.

These problems occur as a result of the inability of older cultivars to perform satisfactorily under modern production systems, growth modifications associated with mechanization and the loss of quality resulting from mechanization.

Objectives and/or Research Approaches: Development of production practices that will result in optimum quality at harvest by:

1. Determination of the physiology of quality retention.
2. Development of production procedures that achieve maximum quality and biological efficiency.
3. Development of new or adaptation of old production practices to new and improved cultivars.

APPENDIX II

VRA II

The subjects covered in the tables in the appendix provide supportive information for the needs discussed under each RPA. The broad scope of VRA II makes a completely comprehensive presentation of all needs and research problems awkward. Therefore, this supportive information is presented to give a clearer concept of the research needs and the relative importance of each.

Table II B is a listing of selected vegetable crops and an evaluation based on acreage and value of the current production and an estimated potential for increased production. Tables II A and II B must be used together when evaluating a research proposal. For example, a more uniformly maturing sweet corn would be far more important than a more uniformly maturing squash. Appendix Table II C is a listing of some of the research needs as identified by this committee.

Table II D associates the Research Areas of VRA II with appropriate RPA's and shows the SMY support recommended for each.

Table II E presents the current and projected needs, compared to current levels, for technical and non-technical support for RPA 204.

It is the considered opinion of this committee that the greatest benefit from increased support for VRA II should be in the area of technical support rather than in professional or SMY increases. Present funding levels do not permit the employment of adequate technical help to efficiently utilize the professional already engaged in research in this area.

Table II A. Priority ratings for research in Vegetable Research Area II in the major sub-areas on each crop

RESEARCH AREA	Potato	Fresh market tomato	Processing tomato	Pepper[1]	Watermelons	Processing cucumber	Fresh market cucumber	Cantaloupes	Squash	Sweet Potato	Other root crops[2]	Southern peas	Snap beans	Lima beans	Cabbage	Leafy greens[3]	Broccoli - Cauliflower	Onions	Lettuce and escarole	Okra	Eggplant	Sweet corn	Greenhouse crops[4]	Mean numerical priority rating
CROP MANAGEMENT																								
Crop Protection																								
Insecticide	2[5]	2	2	3	3	2	2	2	1	1	2	2	2	2	2	1	1	2	2	2	2	1	1	1.8
Fungicide	3	2	2	2	2	2	2	2	1	3	2	2	2	2	2	2	2	2	2	2	2	2	1	2.0
Herbicide	1	2	2	2	3	1	2	1	3	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2.1
Non-chemical pest control	2	1	1	3	2	1	1	1	1	1	2	1	1	2	1	1	1	2	1	3	2	1	1	1.4
Crop Culture																								
Water, temp., soil	1	2	2	2	3	1	2	1	3	1	1	2	1	1	2	1	2	1	2	1	2	2	2	1.5
Fertilizer, spacing, and water	1	4	1	1	2	2	3	2	3	2	1	1	1	1	2	1	2	1	2	1	2	2	2	1.7
Mechanical operations	3	1	1	1	3	2	4	2	3	1	1	1	2	2	2	3	2	1	2	2	2	2	2	1.9
CROP GROWTH																								
Characteristics																								
Germ emergence	3	1	1	1	2	1	2	2	3	3	1	1	1	1	1	1	2	1	2	1	2	1	4	1.6
Maturity	4	1	1	1	4	1	3	3	4	4	1	1	2	1	1	3	1	2	2	1	2	1	4	2.3
Morphology	4	4	3	1	4	1	3	4	4	1	3	2	4	4	2	2	4	3	2	4	2	3	4	2.9
PLANT DEVELOPMENT																								
Seed physiology	4	2	2	2	3	2	2	3	3	4	1	1	1	2	2	2	2	2	2	1	2	3	4	2.2
Growth and dev.	2	2	1	2	2	1	2	3	2	2	2	1	2	2	2	2	2	2	2	3	1	2	1	1.8
Mean numerical priority rating	2.5	2.0	1.5	1.7	2.7	1.6	2.3	2.1	2.6	2.1	1.6	1.4	1.8	1.8	1.8	1.8	1.9	1.8	1.9	2.2	1.9	1.8	2.5	

Footnotes for Table II A

1. Includes: hot, pimento, bell and other sweet types.

2. Includes: turnip, beet, carrot

3. Includes: mustard, collard, turnip, spinach, kale, New Zealand spinach chard (for greens).

4. Includes: tomatoes and cucumbers.

5. Priority ratings:

Priority designation	Definition
1	Critical - need research for industry to continue
2	Important for rapid progression
3	Difficult to justify based on current importance of the crop
4	Cannot justify based on current importance of crop

Table II B. Crop importance and potential.

Crop	Mean rating of importance[y]	Potential for increase[z]
Potato	1	1
Fresh market tomato	2	2
Processing tomato	16	4
Pepper	8	3
Watermelon	3	3
Processing cucumber	10	4
Fresh market cucumber	12	4
Cantaloupe	11	4
Squash	20	3
Sweet potato	4	2
Other root crops	9	5
Southern peas	19	4
Snap beans	7	3
Lima beans	22	3
Cabbage	6	3
Leafy greens	17	4
Broccoli-Cauliflower	14	5
Onions	13	4
Lettuce-Escarole	15	4
Okra	21	3
Eggplant	18	2
Sweet corn	5	5
Greenhouse crops	23	5

[y]Mean rating based on acreage and value.

[z]Based on possible acreage increases: 1=0-10% increase; 2=10-20% increase; 3=25-35%; 4=40-50%; 5=over 50% increase.

Table II C. Individual crops and some specific problems identified.

Crop	Suggested research areas
Potatoes	Seed stock dormancy, growth regulators, chem. weed control, general production practices if and when new cultivars adapted to region are introduced. Chemicals for control of sporadic pests like corn-borer and tubeworn.
Fresh market tomato	Causes of rough fruit, quality, trickle irrigation, hormone to concentrate ripening, mulch systems for mechanical harvesting.
Processing tomato	Hormone to concentrate ripening and resulting effects on quality (e.g. wall thickness) economics of mulch systems. Direct seeding systems, pest control, moisture control, increase yields. An alternate for toxaphene for cutworm control (pre-planting treatment).
Pepper	Same as for processing tomatoes. Also trickle irrigation.
Watermelon	Harvest aid, ripeness index, moisture relations, uneven ripening, effect of herbicide chem. comp.
Processing cucumbers	Growth regulator control of fruit set, production practices to facilitate mech. harvesting, precision seeding. Instability of sex expression in gynoecious hybrids. Alternate for lindane.
Cantaloupe	Environmental effects on quality and control measures for consistent quality prod. technology for mech. harvest, substitute for lindane.
Squash	Fruit set, production tech. for once-over harvest. Alternate for lindane on summer or fall crops.

Table II C. (cont.)

Crop	Suggested research areas
Sweet potato	Sprout production, root piece planting, inconsistent root development, mechanized production, factors causing inconsistent quality in the can. Growth requlators. Insecticides for control of sweet potato flea beetle, white grubs, and Diabrotica spp. larvae.
Southern peas	Relation of soil N, nodulation, yield, and degree of vining, uniformity of pod set and maturity, soil H_2O vs yield, mechanization of production, growth regulators, control of vine growth. Alternate for toxaphene.
Beans	Seed and seedling physiology, plant production for mechanization and top yield, macro and micro nutrient fertilization, seed uniformity vs growth, development and maturity, increase protein supplying power of vegetable legumes used as food. Improved insecticides for control of caterpillars and bean beetles.
Greens	Seeding equipment, plant population, intensified production system, selective chemicals for control of aphids and caterpillars.
Broccoli, cabbage	Uniformity of maturity, mechanization of production to facilitate harvesting, direct seeding. Selective chemicals for control of caterpillars and aphids. Alternate for toxaphene for cutworm control.
Okra	Plant population for mechanized production.
Sweet corn	Seed physiology, non-uniform maturity, use of chemicals vs chemical composition. Parasites, predators, or improved chemicals to control earworms.

Table II C. (cont.)

Crop	Suggested research areas
Greenhouse crops	Quality and intensity of light transmitted by covers, critical CO_2 levels, CO_2 level and light relationships, growing media, mineral nutrition and water use.
All crops	Effects of chemicals, especially herbicides, on chemical composition, identification of amino acids and their role in growth, development, and quality. Seed and seedling physiology.
Fruiting crops	Rate of fruit development relative to seed development, seed coat hardness, color development and seed (or embryo) maturity as well as relationship to the environment.

Table II D. The number of SMY's currently assigned compared to the number needed in each major subgroup.

Research area	RPA	Present number of SMY's[W]	Recommended[X]
CROP MANAGEMENT			
Crop Protection	204, 205, 206, 306		
Insecticide (chemical)		6.5	13.0
Fungicide		25.0[Y]	27.0
Herbicide		10.0	11.0[Z]
Non-chem. pest control		8.6	20.0
Crop Culture	304, 305, 306		
Water, temp., and soil		7.0	10.0
Fertilizer, spacing and moisture		21.0	23.0
Mech. operation		3.0	5.0
CROP GROWTH	304, 305		
Germ and emergence		1.5	3.0
Maturity		1.5	3.0
Morphology		1.0	2.0
PLANT DEVELOPMENT	304, 305, 306		
Seed Physiology		0.0	2.0
Growth and Development		8.0	9.0
OTHER	214, 402	7.3	4.0

[W]Estimates based on best information available.

[X]Recommended - level within 10 years to provide solution to problem.

[Y]A decrease of 1/4 with a subsequent shift of this amount to non-chemical control measures to study the life history and survival of organisms in nature is suggested.

[Z]Some researchers suggest that, based on present SMY needs and estimated trends this level should actually be 24 SMY's within 10 years.

Table II E. A comparison of the current level and the current and projected technical and non-technical research on chemical and non-chemical methods of pest control in vegetables in the Southern Region of the U. S.[y]

Research category	Current level	Current needs	Projected needs in 5 years
		Technical[z]	
Insecticides	9.3	19.0	15.0
Non-chemical	6.9	25.4	29.3
Total	16.2	44.4	44.3
		Non-technical[z]	
Insecticides	3.2	17.3	17.8
Non-chemical	2.7	27.1	45.7
Total	5.9	44.4	63.5

[y]Source of data is estimates obtained after contacting 58% of the entomologists in the Southern Region.

[z]Man years.

VEGETABLE RESEARCH AREA III

Harvesting, Handling, and Marketing

Harvesting and handling research is designed to develop and test equipment, processes, and systems for vegetables that maximize retention of product quality and improve the efficiency of operations. Other goals include retaining more of the plant residues in the field, enhancing utilization of products and/or by-products, and reducing processing wastes. Coordination of efforts in this area is designed to optimize benefits to producers, processors, distributors, and consumers. Also, it must be recognized that these objectives are interrelated to variety development through the need to develop varieties suitable to mechanical harvesting.

Research in marketing is intended to develop improved economic, physical, and/or biological systems to deliver vegetables to the consumers in useful forms. Discovery of new uses for vegetables and their by-products is included in this area. Included are utilization for both industrial and artistic needs, as well as uses for human and animal food.

New systems of mechanical harvesting and handling are needed to protect quality, increase yield of edible products, and reduce labor requirements. Also, marketing innovations must rapidly move freshly harvested vegetables through the channels of trade and into the hands of the consumer. Expeditious methods of delivery will reduce losses due to respiration, decay, and excessive time in transit, storage, and distribution. Both engineering, biological, and marketing skills will be required in developing the necessary processes and techniques.

At present there are approximately 40.6 Scientific Man Years (SMY's) devoted to harvesting, handling, and marketing research (VRA III) in the Southern Region. The current and recommended distributions of these SMY's by Research Problem Areas (RPA's) are listed in Table VI A. In this section on VRA III for each individual RPA there are: (1) an assigned priority ranking (1-4), (2) a situation evaluation, and (3) a discussion of the objectives and research approaches. In the Recommendations and Appendices section, research priorities for harvesting, handling, and marketing were assigned to the vegetables produced in the Southern Region (Table III A).

VRA-III Research Goals

A. Mechanization of Vegetable Production

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-305	1	10.6	11.0	12.2	25

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Vegetable crops must be mechanized if they are to remain a substantial part of diets of Americans. The harvesting of most vegetable crops requires tremendous expenditures of human effort, and is one of the few remaining occupations in the U. S. which requires hard physical effort of a repetitive, boring nature. Our social system actively discourages people entering into a life occupation as a vegetable harvester and this appears true regardless of the wage scale paid. It is imperative that mechanical harvesting equipment be developed for all crops that we produce in the Southeast. Engineering and development of vegetable harvesting machinery must be performed by public service organizations because unlike tractors, tillage equipment, and grain harvesting machinery, the limited sales appeal of a vegetable harvester prevents investment in research and engineering by major farm equipment companies and short line companies generally do not have the resources or the research engineers to do the job. Vegetable crops require a specialized, highly developed machine for each separate crop. This is unlike grain harvesting combines in which one machine works well on many types of grains. In addition, a vegetable harvesting machine must be engineered to a much higher level of performance before a manufacturer will take it on to build and sell.

Closely associated with mechanical harvesting is the handling of the product. As a general rule, equipment and procedures must be developed simultaneously with harvester development for the mechanized handling from the harvester to the packing shed and from the packing shed to the market system. In many crops, this requires a completely new system of production, harvesting, and handling.

Objectives and/or Research Approaches:

1. Mechanical harvesting research should be expedited for all vegetable crops of commercial significance in the South.

2. A systems approach to production research is needed to develop varieties, production practices, mechanical harvesters, and handling methods which are compatible. For example, engineers must develop specifications for plants before plant breeders can develop varieties which are adapted to mechanical harvesting and handling.

3. Equipment and procedures need to be developed for postharvest handling which will minimize the degradation of quality occurring after harvest.

4. The large number of vegetable crops and the limited engineering manpower available at southern research stations makes it imperative that duplication of efforts be held to a minimum.

B. Production Management Systems for Vegetables

Research Problem Area	Priority 1-4	Current	Scientific Man Years (SMY's)* No Increase	10% Increase	Recommended
RPA-306	1	2.0	2.2	2.6	6.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: An increasing interest in and use of mechanical harvesting and handling of vegetables in the Southern Region is necessary for the vegetable industry to expand and for attractive opportunities to be offered to producers. Current mechanical harvesting and handling information and knowledge obtained for future research must be integrated into a complete production management system that exploits the genetic potential of vegetable crops. For example, a mechanical harvester may efficiently harvest large quantities of a crop per unit of time, but without an accompanying system for removing these same quantities of the crop from the machine and moving it to a fresh market packing and/or processing facility, the effectiveness of the mechanical harvester is greatly reduced. The promise offered by growth regulators, improved varieties, and cultural systems for more uniform maturation of vegetable crops will amplify this handling problem. Therefore, effective management systems must be developed for the preharvest to processing facility portion of the vegetable production cycle.

Objectives and/or Research Approaches:

1. Various components of a mechanized harvesting and handling system for a vegetable crop should be simultaneously developed such that compatibility of these components is assured, thereby allowing the development of an effective management system.

2. The systems analysis approach should be applied to the preharvest-to-processing facility portion of the vegetable production cycle.

3. Factors such as timeliness of growth regulator application, harvest scheduling, sorting and disease control on the harvester or immediately after harvest, transfer of product from harvester to transportation containers, and transport to processor must be studied.

4. Optimal combinations of these factors must be developed for maximizing the economic returns to the vegetable producer and the vegetable industry.

C. Production of Vegetable Crops with Improved Consumer Acceptance

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-402	1	2.3	2.3	2.5	5.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Consumers expect and should receive vegetables from the South that have good eating quality and good nutritive values. This quality must be maintained if the South is to continue to obtain a competitive position in the market.

Totally mechanized systems of production, harvesting and handling are being developed for most southern vegetable crops, and there is a critical need for more information with regard to effects of these new systems on quality of the raw and processed product.

Objectives and/or Research Approaches:

1. Studies should be designed to evaluate the effects of new production and harvesting methods on quality of the raw and processed product.

2. An integrated research program should be designed that would study effects of plant breeding, culture, physiology, mechanical harvesting, handling and processing and their interactive effects on quality and nutritive values of vegetables crops.

3. Research should be designed that would investigate the raw product quality characteristics of a given vegetable crop and determine the crop's suitability for fresh-market and the various processed products.

4. Procedures should be developed that better identify, measure and correlate consumer acceptance to raw product quality.

D. Quality Maintenance in Storing and Marketing of Vegetables

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-404	1	8.5	9.2	10.2	20.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The consumer receives inferior quality of many vegetables because of inadequate quality maintenance after harvesting. Most of the quality and nutritional loss occurs as a result of chemical, physical and physiological changes that occur during grading, handling, ripening and storage. Prevention of these losses will give fresh-market buyers, processors and consumers a better product at a lower cost. With mechanical harvesting, the postharvest problems are maximized and the product quality will be affected by such factors as several maturity stages obtained by once-over harvesting and rapid deterioration induced by mechanical damage.

Objectives and/or Research Approaches:

1. Postharvest changes of machine harvested vegetables must be examined at various maturity stages of the raw product.

2. Handling treatments need to be developed to retard raw product deterioration.

3. Physical and chemical reaction that occur in the raw product after harvest must be measured in relation to storage temperature, humidity, and duration.

4. Enzyme systems involved in product deterioration need to be determined during postharvest handling and storage.

5. New systems for storage and handling for retention and/or improvement of desired color, flavor, texture and nutritive value must be investigated.

6. Packaging and other methods of protection need to be investigated so that there will be proper protection and atmosphere for quality maintenance.

E. Improvement of Grades and Standards-Vegetable Products

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-501	1	0.1	0.4	0.5	2.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The usefulness of market information, important in the conduct of trade and establishment of a fair price, is dependent upon adequately descriptive grades and standards. Many current grades and standards are not as useful as they could be because they do not adequately cover the characteristics desired by users. Grades and standards could be improved by the substitution of objective measurement of characteristics for the subjective techniques now in use.

Objectives and/or Research Approaches:

1. Quality and nutritive values of southern vegetables that are desired by the fresh-market buyers, processors and consumers must be determined.

2. Instrumentation and methodology that will allow easy determination of characteristics need to be developed so that they can be used to distinguish levels of quality found in products.

3. Objective measures of quality should be developed to replace subjective ones.

4. Sufficient data to allow changes in grades and standards that realistically reflect new production harvesting, handling, and processing practices must be obtained.

F. Marketing Efficiency of Agricultural Products

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-503	4	4.8	3.8	4.0	6.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Marketing costs for vegetables account for approximately 70% of retail prices. Continued demands by consumers for more marketing services, including processing and packaging, can be expected to bring about further increases in marketing costs. Since there is likely to be no reversal in the trend of consumers demanding more services, research in marketing efficiency cannot be aimed only at reduction in cost per se. Instead, it must take into account what services the consumer will pay for and seek alternative methods for meeting these demands so as to provide marketing agencies with real choices in line with optimum use of resources.

There is need for marketing efficiency research with integrated approaches from assembly through retailing. Waste due to spoilage, overlapping and duplication of practices, use of out-dated marketing facilities and layouts, and small inefficient processing facilities represent persistent problem areas needing research. The growing importance of distant markets, both foreign and domestic, for southern vegetables makes research in reduction in bulk and packaging promising in facilitating greater use of rapid transportation in the shipment of highly perishable commodities. This need is especially evident at shipping points where great efficiencies can be attained.

With greater realization of goals in production, expanded markets, and consumer acceptance, research in marketing efficiency has become most essential to the establishment and maintenance of competitive positions for southern vegetables.

Objectives and/or Research Approaches:

1. Economic models should be developed to determine best alternative markets for southern fresh market vegetables.

2. Optimum size of processing facilities for specific vegetables or combination of vegetables based on least cost must be determined.

3. Ways and means of packaging to maintain quality and reduce bulk in shipment of fresh market vegetables must be discovered.

4. Means of reducing loss of vegetables shipped in bulk to distant processing plants should be investigated.

5. Improved methods of transportation must be developed and tested for performance.

6. Containers and packages for vegetables should be evaluated based on cost and suitability and the use of pallets from assembly through retailing.

7. Economic models to evaluate establishing local processing plants versus shipment to distance processing facilities should be developed.

8. The efficiency of existing public and private marketing facilities and layouts must be studied.

G. Supply, Demand, and Price Analysis

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-506	3	3.2	2.4	2.6	5.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Demand for high quality vegetables tends to either remain constant or change only slowly over time depending on the dietary habits of consumers. Due to the interaction of variations in the quantities supplied with demand, prices for some vegetable crops have fluctuated by 100% or more between production seasons and sometimes within one season. This is especially true for those commodities which are regularly consumed as part of the average diet.

To make reliable forecasts of the spplies of vegetables that will be brought to market, information must be provided as to the number of acres planted plus weather and disease and insect conditions in each production area. Many excellent crops have been ruined because weather conditions prevented an efficient harvest and/or reduced the quality. Increased supplies from competing production areas have created surpluses on the regional or national market thereby reducing the value of a crop of superior quality. Other variations in supply have come as growers altered their annual planting intentions based on market results from previous years.

Data on new uses for vegetables in consumption in the fresh form and/or for processing are needed to aid in demand forecasting. Also, changes in the quantities purchased must be observed, recorded, and analyzed to determine the expected level of demand for the future.

Objectives and/or Research Approaches:

1. Efficient methods must be formulated for collecting information on the determinants of the quantities of vegetables that will be supplied.

2. Surveys of the indicators of demand must be readily available to project the quantities that will be purchased at various price levels.

3. Accurate data from all vegetable production areas in the United States must be collected to give researchers an indication of annual planting intentions before the vegetable crop is planted. Also, supply studies will require weather, disease and insect, and harvesting condition information provided on a regular continuing basis as the crop matures.

4. Projections of past trends as well as expected interaction of supply and demand must be made to forecast the price for vegetables at all levels in the marketing channel. Comparison of previous records can be used to provide an indication of fair marketing margins.

H. Competitive Interrelationships in Agriculture

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-507	2	1.6	2.0	2.2	4.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Emerging, new, and established production areas need to evaluate the relative profitability of their vegetable crops. Cost or input reducing technology in growing, harvesting, processing, and/or transporting vegetables must be considered especially when the competitive interrelationships between areas would be significantly altered. The directions of shifts in consumer preference patterns need to be determined to give direction in predicting acceptance of new vegetable crop varieties or new forms of processed products. Also, guidelines as to the pertinent variables of market structure need to be developed to enable researchers to isolate the critical factors for study.

Objectives and/or Research Approaches:

1. Information gathering and programming techniques need to be developed to allow for constructive comparisons of costs and returns from similar vegetable enterprises in different growing regions.

2. Competitive evaluation must include seasonal supply patterns as well as location in relation to demand in centers of population for each producing region.

3. Optimum market structure situations should be projected as guidelines for vegetable producer and industry groups to consider.

4. Research should be designed to determine the transportation, seasonal, production, and demand interrelationship for the vegetable crops produced in several regions.

5. Cost studies should be initiated to estimate the relative profitability of alternative vegetable production and/or processing enterprises and techniques.

6. Consideration should be given to efforts for evaluating consumer preferences for vegetables produced in different regions.

7. Research should isolate changes in market structure and market performance resulting from alternative conformations.

I. Development of Domestic Markets for Farm Products

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-508	3	0.9	0.9	1.0	2.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Some southern vegetables are not well known in markets outside of the South. It is possible that consumers in other areas would purchase them if they were made available, as has been demonstrated with pole beans and southern peas in fresh or processed forms. Research to test consumer acceptance of unfamiliar or new products in areas outside their usual distribution patterns may help to expand product merchandising of certain southern vegetables. Their use in governmental food programs could also be beneficial.

Many producers of vegetable are at a disadvantage in marketing because of the small size of their operations. Volumes produced are often insufficient to warrent expensive market preparation or to interest buyers who generally represent large firms. Research that would expand roadside or other small volume marketing at a relatively low cost would improve opportunities for small volume producers.

Objectives and/or Research Approaches:

1. Studies should be designed to determine the extent of the market potential in areas outside of their present normal distribution patterns for current southern vegetables and their products or new ones which may be developed.

2. Research designed to measure consumer response to alternative advertising, educational and promotional techniques may help to expand existing domestic markets for southern vegetables.

3. Research is needed to guide small volume producers in more efficient, lower cost food distribution systems in urban and rural areas.

4. Research is needed to guide development and operation of food programs including vegetables in fresh or processed form.

J. Performance of Marketing Systems

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-509	2	5.4	5.4	5.9	8.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Marketing systems have been changing rapidly and becoming more complex with the tendency toward fewer, but larger, more specialized and more capital-intensive firms. The trend has been toward tighter vertical coordination among production and marketing activities. Implications of these changes are crucial in planning and conducting research to improve performance of agricultural marketing systems. To understand and evaluate performance of today's farm firms it is necessary to understand the organization and behavior of firms supplying farm production inputs, those marketing farm commodities, and the manner in which each relates to the farm sector. Comprehensive and systematic research is required to help answer pertinent questions.

Objectives and/or Research Approaches:

1. The objective is to devise and carry out research encompassing various systems and subsystems which will aid in understanding and improving performance in marketing of vegetables: a series of comprehensive, interrelated programs of research on both the horizontal and vertical dimensions of the food and fiber complex is needed.

2. A general conceptual model of the vegetable subsector would be needed as a framework for the many more specific research projects to be undertaken. A series of projects would be undertaken to: (a) determine the organizational configuration of the system and factors within and outisde the system which relate to that configuration, (b) determine the sequences and processes of product flows among stages of the system, and (c) determine the nature and extent of horizontal integration at each stage and pricing or other mechanisms of vertical coordination among stages.

3. Production and marketing cost relationships and demand functions would be estimated at appropriate firm, stage, and sectoral levels.

4. In conjunction with the above there is need for research on a cross-commodity or functional basis. For more detailed explanation see U.S.D.A. "A National Program of Research for Marketing and Competition". Washington, D. C., June 1969.

K. Foreign Market Development

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-601	4	1.2	1.0	1.0	1.2

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Foreign market sales of fresh or processed vegetables from the United States have been limited due to the high costs of transportation, processing, and import duties. Although growing affluence in some nations has led to a trend of increasing use of processed vegetables, most U. S. vegetable processors have not been able to sell significant quantities of their products at competitive prices in markets overseas. Also, the lack of mechanical refrigeration in many areas has reduced the market for frozen vegetables from the U. S. To open foreign markets to U. S. fresh vegetables, new packing and transport techniques will be required to reduce costs and time in transit plus improving arrival condition.

New processing methods such as dehydration may provide avenues to the mass foreign markets for vegetables from the United States. Evaluations will have to be made of the economies of these new processes and the stability of the resulting products. If it is determined that the costs will be low enough and consumer acceptance can be attained, future growth in foreign markets can be expected for U. S. vegetables.

Objectives and/or Research Approaches:

1. Technology must be developed to (a) process export vegetables of stable quality and (b) deliver fresh vegetables in acceptable condition with a low marketing cost.

2. Research should be designed to test containers and transport equipment for cost and efficiency of operation.

3. Studies would have to be made to determine the market acceptance of vegetables shipped in new equipment and/or packages.

4. Processing methods must be developed to lower cost while maintaining quality for the export markets.

5. The foreign markets must be evaluated to determine what the people will accept, the storage facilities, and any changes that are occurring as to population, income, and price levels paid for their domestic vegetables.

VRA III

Recommendations

Totally mechanized systems of production, harvesting, and handling must be developed for southern vegetable crops. Also, as new techniques are proposed, they must be evaluated with regard to their effect on quality of the raw and processed product. A completely new system may be required to produce, harvest, and handle many crops.

Simultaneous development will be required to coordinate the equipment and procedures for mechanized harvesting and handling. These processes must include the movement of vegetables from the harvester to the packing shed or processing plant and from the processor through the market system. Efforts to accomplish these goals will require both fitting the processes to the vegetable crop, as well as fitting the variety of the crop to the process.

At present there are alarming developments which if continued, will result in the virtual demise of segments of the vegetable producing industry in the South. Fresh market tomatoes and okra are just two of several crops that simply will not be produced in the United States in the quantities currently demanded without development of a mechanized production system. This trend will affect almost every southern state.

Emphasis should be placed on the possible complementary effect of mechanization of one vegetable crop on production of others. For example, if the harvest of fresh market tomatoes is mechanized, there may no longer be sufficient labor available to harvest slicing cucumbers. Migrant labor can now be attracted for both crops but probably would not be available for cucumbers alone. While considerable effort and progress has been made toward developing a fresh market tomato harvester, there is little evidence of initiation of research for crops such as slicing cucumbers or squash.

To develop a completely mechanized production system for any vegetable crop normally requires research at every level--breeding, production, harvesting, postharvest handling, and marketing. Many of the crops may not be mechanized in 10 years even if we start now. This should point up the need for urgency in regional coordination and cooperation on a formal basis rather than informally as is sometimes the case now.

To summarize and specifically focus these recommendations, a crop by crop listing of priorities for southern vegetables is presented in the VRA III Appendix (Table III A). This enumeration gives individual priorities to harvesting, handling, and marketing research that were assigned to each crop by the VRA III Committee.

APPENDIX III

VRA III

Table III A. Priority Ratings by Vegetable Crop for Harvesting, Handling, and Marketing Research in the Southern Region.

Crop	Research Area		
	Harvesting	Handling	Marketing
	- - - - - Priority Ranking (1-4) - - - - - -		
Asparagus	4	2	4
Bean, dry	4	4	4
Bean, lima	4	2	3
Bean, snap	4	1	1
Beets, table	4	2	3
Cantaloupe	2	2	3
Carrots	1	1	3
Celery	4	3	3
Cole crops 1/	3	2	3
Cucumber 2/	1	1	2
Eggplant	3	3	3
Escarole	3	3	3
Kale	4	4	4
Lettuce	3	3	3
Mustard	4	1	2
Okra	1	1	3
Onion	1	1	2
Peas, green	4	1	1
Peas, southern	4	1	1
Peppers	1	2	2
Potatoes	3	2	2
Pumpkin	2	2	2
Radish	4	4	4
Spinach	4	1	1
Squash 3/	1	1	1
Sweet corn	4	1	1
Sweet potato	1	1	1
Turnip	2	2	2
Watermelon	2	2	3
Tomato, fresh	1	1	1
Tomato processing	2	1	2

1/ Includes broccoli, brussel sprouts, cabbage, collards, and cauliflower.
2/ Includes both pickling and slicing types.
3/ Includes all types of squash.

VEGETABLE RESEARCH AREA IV

Processing and Utilization

In the U. S. there is a trend towards the consumption of more processed and less fresh vegetables. In 1949-51, the average per capita consumption of fresh and processed vegetables was 114.4 and 83.4 pounds, respectively. For the 1969-71 period, the figures were 99.0 and 114.4 pounds, a reversal. The projection is that this trend will continue and the differences will increase at a rapid rate.

The carryover of processed vegetables has been reduced to a dangerously low level. For instance, the last 10-year average carryover of canned vegetables was 41.1 million cases. In 1973 the carryover of canned vegetables was down to 9.7 million cases. Prospects appear favorable, however, that there will be an increase in the supply of food within a reasonable period of time.

The South has been primarily a producer of fresh vegetables. However, processed vegetables offer many benefits to the consumer. Among these benefits are availability of the product year-round and convenience to consumers at a price they can afford to pay.

Vegetable processing in the Southern Region has not proceeded as rapidly as one might have expected. Yet, this area has a favorable climate for many vegetable crops and most, if not all, of the resources needed for growing and processing many of the crops. In the future, emphasis should be placed on growing those crops that can be produced economically with good yields and excellent quality.

If this region is to maintain its position in the agribusiness and produce its share of the food supply, the development of a strong vegetable processing industry is of critical importance. Obviously some areas of vegetable research have been pursued more vigorously than others. The areas of greatest activity have been devoted to crop production. While this phase is essential, the time has come for a greater research effort in vegetable processing, product utilization, and marketing.

In the research problem area (RPA) presentations which follow, the present situation is evaluated and objectives and/or research approaches are listed.

VRA-IV Research Goals

A. Mechanization of Vegetable Crop Production

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-305	3	1.0	0.5	0.5	2.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: With the growing introduction of mechanical harvesting of vegetables, the processor is presented with a raw product which, in many cases, has grossly different quality characteristics than encountered with hand harvested crops. Those characteristics include contamination with sticks, stones, dirt, weeds, and plant parts, a higher incidence of cuts and bruises, and a wider range of maturity.

It will be of critical importance to a processor that he be able to deal with the raw product problems in an economical, efficient and effective manner.

Objectives and/or Research Approaches:

A. Determine effect of mechanical harvesting on the raw product with regard to processing yield and quality.

B. Develop rapid, objective means for detecting and separating defective raw products.

C. Determine the effect on the final product of a procedural modification designed to adapt to situations arising from the introduction of mechanical harvesting.

B. Production of Vegetable Crops with Improved Acceptability

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-402	3	0.6	0.6	0.6	1.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The consumer is becoming better informed concerning the nutritional value of foods. Thus, it seems that in the near future foods will not be purchased only because they taste good, but also because they are nutritious.

Characteristics that contribute to quality should be defined, identified, measured and evaluated in order to develop and maintain foods with optimum quality. The basic components of food attributes including color, texture, flavor and nutrition, should be more clearly understood before the raw vegetable can be transformed into a finished product of highest quality.

Objectives and/or Research Approaches:

A. Identify the factors that contribute to improving acceptability of processed vegetables.

B. Develop processing methods and procedures that retain and contribute to highest possible quality and acceptability of processed vegetables.

C. New and Improved Vegetable Products and By-products

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-403	2	18.6	17.8	19.6	21.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Per capita consumption of processed vegetables is increasing. An increase of 20% occurred between 1960 and 1972. Indications are that this trend will continue and perhaps even accelerate. Much of this increase can be attributed to the development of new and improved processed products. Convenience seems to be the key word in today's feeding systems. Managers of eating establishments are moving rapidly toward the use of foods that require a minimum of preparation, possess uniform quality and contain higher nutritional values.

Consumers demand variety in their diets; therefore, the development of new products must be a continuous effort. Many new appetizing products can be put together with some imagination and the combination of a few basic ingredients. With the continual rise in the cost of food, now is the time for vegetable processors to make a strong effort to provide the consumer with a variety of products that are nutritious, convenient and economical.

Objectives and/or Research Approaches:

A. Identify the chemical constituents of products that contribute to quality including color, texture, flavor and nutritive value.

B. Investigate chemical changes that occur in vegetables during processing, determine their fate and find means of reducing their loss.

C. Develop new and improved processed vegetable products that provide variety, convenience and improved nutrition.

D. Develop new and improved processing techniques that will contribute to the quality of the product and at the same time reduce the amoung of waste.

E. Evaluate processing characteristics of new vegetable varieties.

D. Quality Maintenance in Storing and Marketing Vegetables

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-404	3	0.8	0.8	0.8	1.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: A weakness in the processing system of some vegetables is the failure to move raw products from the point of harvest to the processing plant rapidly enough and under adequate conditions to insure a processed product of high quality. Since vegetables continue certain respiratory activities after harvest, deterioration develops. Environmental conditions, especially temperature, should be maintained at a level which does not contribute to tissue breakdown. As temperature rises some vegetables, such as sweet corn, exhibit a rapid loss in sugar content. Apparently other changes occur which reduce nutritive value and quality.

Objectives and/or Research Approaches:

A. Determine postharvest chemical and enzymatic reactions which occur in vegetable tissues and their relationship to processing quality.

B. Investigate conditions and handling methods which reduce breakdown of the raw product prior to processing.

C. Study methods of holding vegetables during transportation to preserve original quality.

E. Improvement of Grades and Standards - Crop Products

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-501	2	0.1	0.1	0.1	2.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The use of grades and standards is an effective means of assisting buyers and sellers in determining quality and executing sales. Present grades and standards include physical attributes, but not nutritional attributes. The desires of consumers change, thus present grades and standards for some products may no longer adequately describe the product. It is possible that the existing grades and standards for some products may need to be revised. Nutritional attributes should be considered for inclusion.

Tests using human subjects are expensive, time consuming and not always reliable. In instances where subjective measurements are employed, effort should be made to implement the use of objective tests.

Objectives and/or Research Approaches:

A. Identify easily measured characteristics that can be used to distinguish quality levels of products.

B. Develop objective tests of quality that can be used in conjunction with subjective evaluation.

F. Insure Food Products Free of Toxic Residues from Agricultural Sources

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-701	4	0.6	0.0	0.0	1.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: There is a vital concern over the use of chemicals in the production of agricultural crops. The use of pesticides undoubtedly will continue to be a necessary means of pest control. Growers are interested also in the use of growth promoters. Other chemicals may be used to prolong the storage life of the raw product. More research is needed to determine whether chemical residues are eliminated from the food by the processing methods.

Objectives and/or Research Approaches:

A. Analyze the chemicals applied to crops to determine if their use results in the presence of residues or metabolites in the processed product and determine the effect of processing techniques on their fate.

B. Develop rapid and accurate methods of monitoring the products for presence of residues or metabolites.

G. Protect Food From Harmful Microorganisms and Naturally Occurring Toxins

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-702	4	0.1	0.0	0.0	1.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The consumer expects the food processor to pack products that are not only good to eat and nutritious but wholesome and safe. Since the consumer cannot determine the safety of the foods at the time of purchase, it is the responsibility of processors to insure their safety. The threat of certain microorganisms or their toxins being present in processed foods exists always, especially in those foods that are inadequately processed. Processing methods must be adequate to insure that all foods are microbiologically safe.

Objectives and/or Research Approaches:

A. Develop improved methods of sanitation in the processing plant to remove the threat of microbial contamination of foods.

B. Develop processing techniques for canning low acid vegetables through a more thorough understanding of the resistance of various spores to heat.

C. Identify naturally occurring toxins in vegetables and develop methods for their elimination.

H. Human Nutrition

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-708	2	0.1	0.1	0.5	2.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: The nutritional value of foods has begun to receive considerable attention. The present volunteer practice of nutritional labeling of products will probably develop into mandatory labeling. Even if mandatory labeling does not become a reality, the products not labeled may be less competitive in the market place than those that are labeled. Research is needed to determine the effect of various processing methods on components of the food. The relationship between nutritional levels of pre-processed vegetables and the processed products should be investigated. Research is needed to determine if components of a particular variety, maturity level or a given part of the plant are more resistant to thermal degradation.

Objectives and/or Research Approaches:

A. Determine effect of present methods of storing raw vegetables on their nutritional quality after processing.

B. Determine the effect of raw product production practices on nutritional value of the processed product.

C. Determine effect of various methods of processing, especially thermal, on nutritional value of products.

D. Determine the nutritonal value of products from new varieties as compared to products of existing varieties.

I. Alleviation of Pollution and Disposal of Wastes

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-901	1	0.0	2.0	2.0	2.0

*SMY shifts based on total funds for Southern Region vegetable research.

Situation Evaluation: Various governmental agencies have issued mandates to industries, including food processors, to eliminate pollution. Historically, food processors have used water to carry away the wastes; the effluent was usually directed to a river, lake, municipal sewer or onto land. The BOD of such wastes is often very high. Present problems are due in part to the fact that industry has not concerned itself with proper waste disposal. Even though the cost required to comply with various governmental regulations will be high, time has come to prevent pollutants from entering into our streams.

Processors of at least two types of products should take major steps to prevent undesirable materials from reaching the environment. These are processors of brined and fermented items such as pickles and sauerkraut, and lye peeled vegetables such as sweet potatoes. These are important vegetable products of the Southern Region and research is critically needed for survival of such processing operations.

Objectives and/or Research Approaches:

1. Accelerate research dealing with waste disposal in brine processing plants and in particular with pickles and sauerkraut. Increase research dealing with fresh pack type processing of pickles and sauerkraut.

2. A high priority should be placed on research dealing with lye peeling of sweet potatoes and subsequent waste disposal problems. Also, methods of peeling of sweet potatoes by means other than lye should be investigated.

3. Investigate new methods of blanching to reduce the amount of constituents which leach from the product.

Recommendations

The USDA summary of scientific man years (SMY's) for vegetable research in the Southern Region for 1972 showed only 21.9 SMY's devoted to research designated as processing and utilization of vegetable crops. A total of 198.1 SMY's were devoted to production research. This committee recommends that the research efforts in processing and utilization be increased to at least 33 SMY's within the next 10 years. The committee further feels that the highest priority should be given to research dealing with those crops that are considered to be southern vegetables. In the future, however, as other vegetable crops prove to be adaptable to the Southern Region, these too should receive a high priority for processing research.

Production of processed vegetables is a continuously changing operation with the introduction of new varieties and production and processing methods. Therefore, this committee recommends that investigations in the RPA's previously presented should be continued, strengthened or initiated. Table IV A is a listing of commodities which grow well in the Southern Region and RPA's with their relative importance. Research needs for cucumbers and sweet potatoes are considered critical. These problem areas involve new and improved products (RPA 403) and pollution and wastes (RPA 901).

APPENDIX IV

Table IV A. Priorities for Vegetable Research in Processing and Utilization for Research Problem Areas Designated.*

Vegetable	305	402	403	404	501	701	702	708	901
Snap beans	3	3	2	3	3	3	3	3	3
Broccoli	4	2	2	3	3	3	3	3	4
Cabbage	3	3	2	2	3	3	3	3	2
Carrots	4	4	3	2	3	3	3	3	2
Cauliflower	4	2	2	3	3	3	3	3	4
Celery	4	3	2	3	3	3	3	3	4
Sweet corn	4	4	3	3	3	3	3	3	4
Cucumbers	2	3	2	2	3	3	3	3	1
Eggplant	4	4	2	3	3	3	3	3	4
Onions	3	4	3	3	3	3	3	3	4
Peppers, Pimento	3	4	2	3	2	3	3	2	2
Peppers, Sweet	3	4	2	3	3	3	3	3	3
Potatoes	4	4	2	3	3	3	3	3	3
Sweet potatoes	2	3	1	2	2	3	3	2	1
Tomatoes	3	3	2	3	3	3	3	3	3
Okra	2	4	2	3	2	3	3	2	4
Southern peas	2	2	2	3	2	3	3	2	4
Leafy	2	2	2	2	2	3	3	2	3
Squash	3	4	2	3	2	3	3	2	3
Soybeans	3	2	2	4	3	3	3	2	4
Lima beans	4	4	3	3	3	3	3	3	4
Dry beans	4	4	3	4	3	3	3	3	4
Horticulture beans	4	3	3	4	3	3	3	3	4
Total SMY's desired within 10 years	2	1	21	1	2	1	1	2	2

*Research priorities are assigned by following system:

1. Critical-essential for the survival of the industry
2. Important but not immediately essential
3. Should be conducted, long-range need
4. Low priority

VEGETABLE RESEARCH AREA V

Nutritional and Organoleptic Quality and Regulatory Considerations

This research area is concerned entirely with the properties of vegetable crops as they relate to the consumer. This area has not been researched in depth except for certain crops. The literature on the related subjects is fragmentary, the most comprehensive source of data being USDA Handbook 8 (1). The present lack of emphasis in this research area in the Southern Region is evidenced by the assignment of only 6.9 SMY's out of 226.9 state and federal SMY's (Table VI A).

The importance and scope of this research area have been well summarized in three symposia presented at annual meetings of the American Society for Horticultural Science (2, 3, 4). Compositional data as related to the consumer's needs might be generated as part of research initiated VRA's I through IV of this Task Force Report as well as fundamental studies unrelated to these production and marketing oriented areas.

VRA V may be broken down into three general categories and for convenience these areas will be discussed separatly in this report. Obviously, there may be considerable overlap among these--Food Safety, Nutritional Composition and Consumer Acceptability. The assignment of priority ratings for these areas as was attempted in the other VRA's is neither practical nor appropriate as research in these areas is not directly related to industry survival. Preferably, a high priority should be assigned to all categories of this VRA on the basis of responsibility to the public, this high priority being assigned regardless of the economic value of the particular commodity.

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(1) Watt, B. K. and A. L. Merrill. 1963. Composition of foods. U. S. Dept. of Agr. Handbook 8.
(2) Vegetable Quality. HortScience 5:93-108. 1970.
(3) The Role of Horticulture in Meeting World Food Requirements. HortScience 7:139-168. 1972.
(4) Raw Product Evaluation of Horticultural Products. HortScience 8:105-120. 1973.

VRA-V Research Goals

A. Food Safety

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)*			
		Current	No Increase	10% Increase	Recommended
RPA-402	3	1.4	2.1	2.1	3.0
RPA-501	2	0.1	0.1	0.1	0.5
RPA-701	1	1.8	1.8	1.8	9.0
RPA-702	1	0.2	0.2	0.2	6.0

*SMY shifts based on total funds for Southern Region vegetable research.

I. Protection of vegetable crops from harmful microorganisms

Situation:

Biological contamination of vegetable crops is a major area of concern from both economic and consumer protection aspects. Exposure of highly perishable and disease-susceptible crops to insects, animals and/or microorganisms is inevitable during harvesting, processing and marketing operations. The high humidity and temperature of the Southern Region favor vegetable deterioration and microbial growth, making biological contamination a particular problem for this area.

The adaptability of microorganisms to conditions of pH, temperature and other environmental conditions, and the ability to develop resistance to antimicrobial agents underline the need for continuing efforts to control biological contamination. Furthermore, the development of improved varieties of vegetable crops and of new methods for gathering, processing and handling vegetables requires that standards for control of contamination be continually monitored.

Objective:

Reduction of biological contamination of vegetables during harvesting, processing and marketing operations.

Research Approaches:

a. Identification of sources of biological contamination and the effective elimination of these sources at each stage of vegetable production. (RPA 701, 702).

b. Development of new methods of biological contaminant control which will reduce damage to and improve quality and nutritional value of processed vegetables. (RPA 402, 501, 702).

c. Determination of ideal storage and processing conditions for newly-developed vegetable varieties. (RPA 403).

d. Evaluation of newly-developed handling, processing, and packaging methods to ensure that new sources of biological contamination have not been introduced. (RPA 702).

II. Protection of vegetable crops from naturally-occurring toxins

Situation:

In addition to the proteins, carbohydrates, vitamins and minerals which make vegetables nutritionally important crops, many of these plants contain toxic compounds. The nature and occurrence of toxicants are determined by genetic characteristics of the plant and environmental conditions under which the plant is cultivated. Naturally-occurring compounds frequently impart a degree of insect or nematode resistance to vegetables, a condition for which plant breeders strive, but this resistance may also present hazards to the consumer.

Fortunately, heat will destroy many toxic agents, and proper cooking enables man to consume many potentially harmful plants with no ill effects. However, the conditions for adequate destruction of toxic materials need to be specifically defined for each vegetable. It is possible that certain conditions of heat, pH, ionic content or other processing or storage conditions might enhance toxicant levels, rather than decreasing them.

Objectives:

Determination of toxicologic and pharmacologic properties of naturally-occurring toxins of vegetable crops, and development of methods for detection and removal of the compounds.

Research Approaches:

a. Improvement of detection methods. (RPA 701).

b. Study of acute and chronic toxicity and determination of maximum allowable levels. (RPA 501).

c. Improvement of methods for removal or destruction of toxic agents, and the establishment of standard conditions for effective elimination of the materials. (RPA 702).

d. Identification and characterization of resistance factors or other potentially harmful agents in newly-developed vegetable varieties. (RPA 403).

III. Additives

Situation:

Additives are frequently used to ensure high quality of vegetable products available to the consumer. The definition of food additive is any substance which becomes, directly or indirectly, a component of food or affects the characteristics of the food. Thus, not only are preservatives, coloring agents or flavoring agents included, but also packaging materials or processing procedures which might alter the properties of the finished product.

Because of the favorable growing conditions of the Southern Region, there is wide distribution of vegetable products to processors and consumers of other regions. There must be continued effort to ensure that additives used to enable this distribution are safe and effective.

Objectives:

Development of improved additives and processing procedures to enhance esthetic appearance and ensure continued high nutritional quality of vegetables.

Research Approaches:

a. Elimination of the use of undesirable additives through development of alternative procedures. (RPA 403).

b. Determination of minimal levels of additive required to achieve the desired effect for each particular vegetable crop. (RPA 403).

c. Development of safer and more effective additives. (RPA 403).

d. Evaluation of packaging and processing procedures to ensure that vegetable quality and safety are not jeopardized. (RPA 702).

IV. GRAS (Generally Recognized as Safe) guidelines as applied to vegetable crops

Situation:

Criteria for establishing eligibility of food substances for inclusion in the generally recognized as safe (GRAS) category have been presented in the Code of Federal Regulations (21 CFR 121). According to these criteria, food substances altered by breeding or selection procedures which "may reasonably be expected to alter to a significant degree the nutritive value or the concentration of toxic constituents therein" are subject to affirmation as GRAS by the Commissioner of Food and Drugs.

Vegetable crops have undergone and continue to undergo extensive breeding and selection processes in attempts to improve quality and acceptability. Frequently alterations in vitamin, mineral, protein and carbohydrate content are produced, as well as increased levels of toxic materials which impart insect, nematode or disease resistance to the plants. The active program of vegetable breeding of the Southern Region indicates needed research effort in a number of categories in order to ensure protection of the consumer while continuing to supply nutritious and tasteful vegetables.

Objective:

Development of a program which will ensure safety and nutritional quality of newly-developed vegetable products.

Research Approaches:

a. Identification of vegetable constituents and optimal levels of the constituents for each particular vegetable product. (RPA 708).

b. Analysis of new cultivars for alterations in chemical constituents and the importance of the new alterations of consumers and processors. (RPA 403).

c. Methods for removal or destruction of toxic materials from otherwise acceptable varieties. (RPA 702).

V. Pesticide Residues

Situation:

Pesticide residues form an important part of Food Safety considerations. The initial food-related contact with pesticides involves the field workers, from the time of spraying to harvest. Recent attention has been given to this problem by the Occupational Safety and Health Act (OSHA) which prescribes field worker reentry times following spraying. This is of importance to the vegetable industry because the industry bears responsibility for the safety of field workers but also has a need for the shortest safe reentry periods, particularly prior to harvest. It appears that industry will have to demonstrate with actual research data that field practices are indeed safe. This has already occurred in certain areas, i.e., citrus and other tree fruits. Consideration is also being given to long-term effects of exposure to low levels of pesticides, that is, the chronic effects, in addition to the more common acute effects which are usually expressed as the LD 50, orally or dermally on a particular animal. Industry may be required to show the lack of chronic toxicity of some of the compounds currently being used. Such requirements would significantly increase the cost of developing pesticides.

The vegetable industry has a definite obligation with respect to the environment to insure that only prescribed levels of pesticides are being used and that wastes, such as pesticide cans and bags, are disposed of properly, minimizing contamination of surface waters, etc.

The last decade has brought dramatic advances in the ability to detect pesticides at increasingly lower levels. This has made the concept of zero tolerance untenable and finite tolerances are being established for pesticides on particular crops. Tolerances are based on efficacy, using the smallest amount of chemical necessary for adequate control and on toxicity, chronic as well as acute, based on the amount of insecticide present at harvest.

Research has been performed and should be continued, attempting to reduce residues on marketable crops in the event of an over-tolerance amount of insecticide present. This can have great economic importance to particular individuals but is a difficult area of research since most pesticides are formulated to remain on the crop and hence are not easily removed without destroying marketability.

Pesticides used on a minor crop present a pesticide label registration problem. The IR-4 project, "Research Required to Meet Legal Requirements for Minor Uses of Agricultural Chemicals", was initiated to assist in this area. The primary objectives of this project are to evaluate and coordinate the assembly of necessary data required by the Environmental Protection Agency to obtain a registered label and a tolerance or register for use. IR-4 considers only those chemicals that have completed all toxicology requirements, depending on the initial petition by the manufacturer for use clearance on major crops for the necessary toxicology required by EPA-FDA. IR-4 performs a useful function for the vegetable industry and its continued operation should be supported as many vegetable crops are grown on a small scale and need special pesticides (5).

Objectives:

Research in the pesticide residue aspects of Food Safety for the vegetable industry is considered to be essential and should be continued after assessment from a practical health viewpoint of the thousands of studies already conducted on residues.

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(5) A complete treatment of this subject by a University-EPA-USDA ad hoc subcommittee appeared in August 1973 entitled "The Development of Data Required for Registration of Pesticides for Specialty and Small Acreage Crops and other Minor Uses".

Research Approaches:

a. Residue research in support of labeling of chemicals for use on vegetables, including minor uses. (RPA 701, 702).

b. Reduction of residues on marketable crops. (RPA 702).

c. Determination of safety for agricultural workers. (RPA 701).

d. Minimizing contamination of the environment from pesticides. (RPA 701).

Food safety as related to the market gardener and home vegetable gardener must be evaluated differently from food safety as related to the large commercial grower. Most of the factors identified above as relating to consumer protection could be applied to the home gardener as well as to the commercial producer, but with variations and some degree of further implications.

The desire for high-quality produce is one of the main reasons consumers sometimes become producers. A successful home gardener generally has a better chance to select quality from home-grown rather than store-bought produce due to elimination of handling intervals. Even so, he is in need of the very best practices which lead to the production of high-quality produce. Likewise, the home producer needs to know what factors of production affect the nutritional level of the produce he grows.

From the standpoint of home producers, the major responsibility of research appears to be associated with insuring that food produced for local consumption is safe to consume. Since many producer restrictions are levied at the market level, an abundance of difficulties usually arise in placing restrictions on home producers and market gardeners in order to enforce food safety standards. Allowing home gardeners to purchase only safe-to-use materials has been one of the chief ways of regulating such things as pesticide residues; however, continued research is needed to insure the best possible pest control commensurate with least likely abuses. Proper labeling and educational programs appear to be the best means of eliminating abuses where residue sampling cannot be a practical regulatory method. We must keep in mind that what is suggested to be used on roses may end up applied to tomatoes only minutes before harvest.

Since home gardeners use composts, manures and home concoctions, more needs to be known about the possible affects of biological contaminants and naturally-occurring toxicants (e.g. arsenic on chicken manure).

Because of the extent of freedom one has to grow whatever is desired using whatever means desired, restrictive regulation of forbidden plants and chemicals would be difficult. Educational programs emphasizing the GRAS listing of safe foods and EPA or FDA regulations are essential. Close tie-ins between research and extension are the key to success in this area. Research on food safety as outlined above, although primarily aimed at commercial production, must simultaneously be concerned with this aspect.

B. Nutritional Composition and Consumer Protection

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-403	4	2.7	2.0	2.0	2.0
RPA-708	1	0.3	0.3	1.0	10.0

*SMY shifts based on total funds for Southern Region vegetable research.

I. Nutritional Composition

Situation:

Both processed and fresh vegetables have traditionally formed a very significant percentage of the human diet. Vegetables are good dietary sources of certain nutrients and of lesser importance in supplying others. Green vegetables are good sources of vitamin C, vitamin A, thiamine, riboflavin, niacin and calcium. Yellow vegetables have historically been associated with their content of β-carotene (provitamin A). While the relative stability of many essential nutrients to temperature, pH and oxidation is understood, little effort has been made to study the interactions or possible synergisms in stability which might arise as a result of processing operations.

The results of the "Ten State Nutrition Survey" (6) and of the "White House Conference on Food, Nutrition and Health" (7) have indicated that a new emphasis is justified in relation to studies concerning the nutritional composition of vegetables. One notable factor brought to light by these surveys has been the widespread occurrence of clinical or borderline deficiencies of calcium, vitamin A, iron, thiamine and vitamin C. These nutritional deficiencies are even more significant when consideration is given to the fact that the segments of the population hardest hit in the rural South are those which traditionally have had the highest consumption of fresh vegetables in their diet. These deficiencies, on a regional or national basis, are still of striking significance even when processing losses are taken into account.

These factors all suggest the need for greater research efforts into basic nutritional composition studies of vegetable crops with particular emphasis on effects of current processing operations and stability of nutrients under various handling, packaging and storage procedures in the fresh market. The most pressing need in the area of research on nutritional composition of vegetables is the elucidation of interrelationships,

(6) United States Public Health Service. U.S. National Nutrition Survey. Washington, D. C. 1970.
(7) President of the United States. White House Conference on Food, Nutrition and Health. Final Report. Washington, D. C. 1970.

synergisms and antagonisms between essential nutrients from the standpoint of biological availability. The distribution of borderline deficiencies strongly suggests the presence of factors (genetic or environmental) which reduce the biological availability of certain essential nutrients in vegetable foods.

Objective:

Improving the nutritional composition of vegetables and identification of the principle nutritional components in each kind and important variety.

Research Approaches:

a. Varietal and environmental effects: It is becoming increasingly evident from chemical and nutritional compositon studies that as much variation may exist within a crop for a particular nutrient as exists between two closely related vegetables. This suggests that appreciable varietal and environmental effects are present in relation to composition. Further credence to this assumption is the fact that it has been possible to develop high lysine corn and wheat varieties and high-protein varieties of many crops. Searching out genetic, cultural and environmental factors which influence nutrient composition in other crops should give impetus to studies with vegetables designed with similar objectives (RPA 403).

b. Identification of primary nutrients and an updating and expansion of our knowledge concerning the composition of certain primary nutrients in vegetable crops are urgently needed. From the standpoint of urgency, initial efforts should be made to analyze our principle vegetable crops in terms of the specific nutrients named in the FDA's Suggested Guidelines for Nutritional Labeling of March 14, 1973 (8). This information is simply not available for many of the vegetables grown commercially in the Southern Region. Recognizing the fact that most laboratories are not equipped or staffed to routinely handle voluminous numbers of analyses, it would seem advantageous to give serious consideration to regional cooperative studies of this nature. In this way, several laboratories with specific capabilities could effectively contribute to the collection of data on crops of mutual interest to states within the region. Efforts should be intensified to evaluate primary nutrients in vegetables from the standpoint of their contribution to the total diet. Following preliminary studies, it will be necessary to identify those vegetable nutrients which contribute on the average of 10% or more of the adult Rec-

(8) Federal Register. Food Labeling. Dept. of Health, Education and Welfare, FDA, March 14, 1973.

ommended Daily Allowance (9) and then concentrate long-range projects on these particular nutrients. Tempering these studies should be consideration of the essentiality of the primary nutrients with emphasis on those specifically named as deficient in the "Ten State Nutrition Survey" (RPA 708).

Urgent need exists to concentrate nutritional research in vegetable crops on the following nutrients:

1. Vitamin A (represented as β-carotene in plant tissues) deficiencies are most widespread than those of any other vitamin. Adequate analytical procedures are available for this vitamin.

2. Ascorbic acid (vitamin C) is universally recognized as the antiscorbutic vitamin and fresh vegetables have long been valued as an important dietary source of this vitamin. Analytical techniques for ascorbic acid are subject to many inherent errors since the presence of numerous different metallic ions interferes with normal extraction procedures. Some efforts may be needed to adapt existing techniques to ascorbic acid extraction from vegetable slurries.

3. Calcium and iron are the essential minerals of greatest immediate interest in relation to vegetable research. These and most other essential minerals (with the exception of P) are routinely analyzed by atomic absorption spectrophotometry. Adequate analytical methods are available for the minerals.

4. Thiamine, riboflavin and niacin are increasing in importance as constituents of vegetable crops. This arises from the fact that traditionally enriched flour products (bread especially) have served as a major dietary source of these nutrients. The per capita consumption of enriched bread has been on a steady decline, thus increasing the relative importance of other foods as dietary contributors. They lend themselves adequately to modern chemical methods of analysis.

5. Most vegetable crops are not ordinarily considered as major sources of dietary protein. The legumes, however, are relatively rich in protein and should be given proper credence as significant sources. Most vegetable proteins are borderline or deficient in at least one essential amino acid; lysine, threonine and the sulfur-containing amino acids primarily. Metabolically the value of a protein is more closely associated with its essential amino acid profile than to quantitative

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(9) "Recommended Dietary Allowances". Food and Nutrition Board, NAS-NRC, Washington, D. C. (1974).

amounts. Therefore, any determination of protein in vegetable crops should include amino acid analyses with special reference to interrelationships with other essential nutrients.

Plant breeding studies should give vastly increased attention to developing varieties of vegetable crops with improved (and certainly not reduced) nutrient composition in relation to contribution to total diet. Extensive compositional data needs to be maintained on all new varieties as a function of cultural and environmental practices.

c. Biological availability: Studies of biochemical and nutritional composition without the accompanying biological availability data are of limited usefulness in evaluating vegetables as dietary ingredients. Utilization of protein is influenced markedly by essential amino acid profile, many vitamins are subject to oxidative and thermal lability, mineral availability is extensively altered by synergistic effects or by the presence of chelating agents such as phytic acid. The effects of processing operations on nutrient composition has not been extensively studied with current varieties except in isolated instances and references on the effect of processing on biological availability are essentially non-existent in the literature.

It is recommended that studies be undertaken to establish the relative biological availability of prime nutrients in the vegetable crops of economic importance to the Southern Region.

d. A nutritional data bank including compositional information from varied genetic and environmental series would be valuable to horticulturists and nutritionists. With increasingly voluminous quantities of scientific literature and with the ever-increasing demands on the time of researchers, it is apparent that a more comprehensive system is needed to assemble and disseminate compositional data on vegetable crops. One logical approach to such a system would be the establishment on a regional or national basis of a Nutritional Data Bank.

The purpose for such a data bank would be to assemble existing information pertaining to the nutritional composition of vegetables in a computerized retrieval system. As new data are supplied by researchers in the region, they would be fed into the computer bank to augment those already present. It would be advantageous to include data pertaining to genetic selection, cultural practices, environment, processing and handling in addition to chemical and nutritional information. With increased emphasis on nutritional value of foods and with the future possibility of mandatory nutritional labeling of processed foods, such information could well prove of immeasurable value to processors and thus to producers of vegetable crops and ultimately to the consumer.

The basic concept of a data bank could well be carried over into breeding and genetics, cultural and production operations, processing and all other phases of vegetable research. The savings in terms of scientific man hours spent in literature searches would be economically significant in itself.

II. Consumer Protection

Situation:

Nutritional labeling as a concept partially fills the need for a system of nutritional education of the consumer. The first obligation of the vegetable industry should be to provide safe, nourishing food to the consumer. The consumer has a right to access the nutritional information concerning the food being purchased. Suitable means of accomplishing this are being established. The first regulations regarding nutritional labeling have already been put into effect.

Objective:

To establish standards which can be of use to the consumer in preparing meals with greater nutritional value (RPA 501).

Research Approaches:

In order for the concept of nutritional labeling to be effective and practical from the supplier's position, it will first be necessary to accumulate appreciable quantities of definitive data on the nutritional composition and biological availability in vegetables. This data might then be the basis for a realistic range of values for incorporation on the labels. The proposed Nutritional Data Bank could be the determining factor in the success of such a program.

A coinciding prerequisite for the usefulness of any system of nutritional labeling is a significant expansion of consumer education programs relating to the interpretation of label information and its application to the whole diet within the family unit. It is conceived that Agricultural Extension personnel will play an indispensable role in this program of consumer orientation and education. In the hands of properly informed public, practical nutritional labeling could contribute substantially toward improving nutritional status and well-being.

C. Consumer Acceptability

Research Problem Area	Priority 1-4	Scientific Man Years (SMY's)* Current	No Increase	10% Increase	Recommended
RPA-703	2	0.3	0.3	0.3	1.0
RPA-704	2	0.1	0.1	0.1	0.5

*SMY shifts based on total funds for Southern Region vegetable research.

Situation:

Vegetables are grown and marketed primarily for human consumption. Consumer satisfaction is, therefore, an area of major importance, yet most of the research relating to vegetables has been placed on other aspects. Work in the important area of consumer acceptance has been neglected. This has resulted in the production and marketing of some vegetables with poor consumer acceptance, especially in the hard-to-define area of flavor. Consumer criticism has, in some cases, developed an atmosphere of uncertainty or distrust which is detrimental to grower, retailer and the consumer. The per capita consumption of fresh vegetables is decreasing despite the fact vegetables are needed for adequate diets and are less expensive than many other foods. Vegetables are not in as great demand nor do they have as high a degree of acceptance as some other foods. For example, rarely, if ever, are vegetables the food featured or promoted by eating establishments to attract customers.

Objective:

To define the quality characteristics which consumers consider essential for acceptance of vegetables.

Research Approaches :

a. Determination of which vegetables have high and low degree of acceptance and why. (RPA 703).

b. To determine regional and cultural preferences for foods eaten at home and away from home. (RPA 703, 704).

c. To determine those vegetable characteristics which can best be used by the vegetable industry as quality indices and which are related to the eating quality of the product, eliminating those criteria which often place an undue burden upon horticulturists and may have detracted from efforts to attack more consumer-relevant problems. (RPA 501).

d. To identify individual chemical and physical components which collectively make up the desired qualities of vegetables. (RPA 402).

e. To define chemical and physical differences resulting from environmental and genetic variation. (RPA 402, 403).

f. To determine how chemical and physical factors interact and how they affect flavor and acceptability. (RPA 402, 403).

g. To determine the genetic basis for flavor and incorporate heritable factors into variety development programs. (RPA 403).

Recommendations:

No other nation avails its citizens a wider or safer selection of foods than does the U. S. By and large, this is a result of our economic system and the general attention given to quality by the industry. This is a result to some degree also of government regulations and laws designed to protect the consumer. As we learn more about our foods and the chemicals used to produce them, it may become necessary to impose new regulations. It is essential, therefore, that the vegetable industry, the consuming public and the appropriate regulatory agencies have available all the facts necessary to make sound judgments and that unnecessarily restrictive regulations not be imposed due to lack of information.

Nowhere is the challenge to integrate research and extension activities more evident than in those areas involving the consumer. Unless the knowledge accumulated on the nutritional and organoleptic properties of vegetables is readily understood by the consumer and those attempting to represent the consumer, and on the other hand unless the needs and desires of the consumer are understood by the researcher, the research will be largely wasted. It is essential, therefore, that the Cooperative Extension Service through its Home Economics and Expanded Nutrition specialists work closely with researchers in this Vegetable Research Area to bring the facts to the consumer and to relay the consumer's needs and desires to the researcher.

The SMY requirement in the Food Safety category is likely to remain fairly constant for a long period of time and is more likely to increase as production and consumption of vegetables increase. The requirement in the Nutritional Composition category will remain constant for at least ten years as researchers catch up in this neglected area. After that initial period, this work might be conducted by fewer workers on a regional basis. The Consumer Acceptance requirement is likely to be high for at least ten years due to the complexity of organoleptic evaluations. The SMY requirement might then drop slightly, but it will still be important to maintain this area of research concurrent with production and variety improvement research.

This recommendation calls for a 464% increase in SMY's in this area. It is recommended that the increase be made as soon as is feasible, preferably by stages within 5 years. In most cases, the persons involved in this research will require extensive training in disciplines such as biochemistry, nutrition, analytical chemistry, microbiology, etc. Training of students in horticulture to meet these requirements should be considered accordingly.

APPENDIX V

No Entries

APPENDIX VI

ADDITIONAL DATA PERTINENT TO THE SOUTHERN REGION

Table VI A. Summary of Scientific-May Year's (SMY's) for Vegetable Research in the Southern Region by Vegetable Research Areas (VRA's) for State and Federal Scientists.

Table VI B. Scientific-Man Years for Vegetable Research - Southern Region.

Table VI C. Acreage by States of Major Vegetable Crops in Southern Region, 1971, as Reported in USDA Agricultural Statistics, 1972. Does not include many smaller acreages of major crops.

Table VI A. Summary of Scientific-Man Year's (SMY's) Vegetable Research Southern Region by Vegetable Research Areas (VRA's) for Experiment Station and Federal Scientists.

Vegetable Research Area (VRA) and RPA		Current[a/]	No Increase[b/]	10% Increase[c/]	Recommended[d/]
VRA - I	Variety Improvement				
RPA 204	Control of Insect Pests	3.2	7.2	8.0	12.0
RPA 205	Control of Diseases	16.2	18.2	18.2	22.2
RPA 304	Improvement of Biological Efficiency of Vegetables	29.4	14.4	14.4	14.4
RPA 305	Mechanization of Production	5.0	14.0	16.0	20.0
RPA 402	Production of Vegetable Crops with Improved Consumer Acceptance	3.9	3.9	6.0	10.9
	Subtotal	57.7	57.7	63.5	79.5
VRA - II	Crop Protection, Growth, Development and Management				
RPA 204	Control of Insect Pests	17.7	20.0	22.0	32.0
RPA 205	Control of Diseases	24.3	24.3	25.0	26.0
RPA 206	Control of Weeds and Other Hazards to Vegetables	12.5	12.5	12.5	14.0
RPA 214	Protection of Vegetables from Pollution	0.2	0.2	0.2	1.0
RPA 304	Improvement of Biological Efficiency of Vegetables	40.3	34.8	39.1	42.0
RPA 305	Mechanization of Vegetable Production	3.0	5.0	6.0	8.0
RPA 306	Production Management System for Vegetables	1.4	2.0	3.0	6.0
RPA 402	Production of Vegetable Crops with Improved Consumer Acceptance	0.4	1.0	2.0	3.0
	Subtotal	99.8	99.8	109.8	132.0

a/ Current data from CRIS printout FY 1972.

b/ No Increase - no change in funds for Southern Region.

c/ 10% Increase - 10% increase in funds for Southern Region.

d/ Recommended - Level within 10 years to provide solution to problem.

Table VI A. (cont'd)

Vegetable Research Area (VRA) and RPA	Current[a/]	No Increase[b/]	10% Increase[c/]	Recommended[d/]
VRA - III Harvesting, Handling, Marketing				
RPA 305 Mechanization of Vegetable Production	10.6	11.0	12.5	25.0
RPA 306 Production Management Systems for Vegetables	2.0	2.2	2.6	6.0
RPA 402 Production of Vegetable Crops with Improved Consumer Acceptance	2.3	2.3	2.5	5.0
RPA 404 Quality Maintenance in Marketing Vegetables	8.5	9.2	10.2	20.0
RPA 501 Improved Grades and Standards	0.1	0.4	0.5	2.0
RPA 503 Market Efficiency of Agricultural Products	4.8	3.8	4.2	6.0
RPA 506 Supply and Demand	3.2	2.2	2.6	5.0
RPA 507 Competitive Interrelations in Agriculture	1.6	2.0	2.0	4.0
RPA 508 Domestic Market Development	0.9	0.9	1.0	2.0
RPA 509 Performance Marketing Systems	5.4	5.4	5.4	8.0
RPA 601 Foreign Market Development	1.2	1.2	1.2	1.2
Subtotal	40.6	40.6	44.7	84.2
VRA - IV Processing and Utilization				
RPA 305 Mechanization of Vegetable Production	1.0	0.5	0.5	2.0
RPA 402 Production of Vegetable Crops with Improved Consumer Acceptance	0.6	0.6	0.6	1.0
RPA 403 New and Improved Vegetable Products	18.6	17.8	19.6	21.0
RPA 404 Quality Maintenance in Marketing Vegetables	0.8	0.8	0.8	1.0
RPA 501 Improved Grades and Standards	0.1	0.1	0.1	2.0
RPA 701 Toxic Residues in Food	0.6	0.0	0.0	1.0
RPA 702 Food Protection from Toxins	0.1	0.0	0.0	1.0
RPA 708 Human Nutrition	0.1	0.1	0.5	2.0
RPA 901 Alleviation of Pollution and Wastes	0.0	2.0	2.0	2.0
Subtotal	21.9	21.9	24.1	33.0

a/ Current data from CRIS printout FY 1972.

b/ No Increase - no change in funds for Southern Region.

c/ 10% Increase - 10% increase in funds for Southern Region.

d/ Recommended - Level within 10 years to provide solution to problem.

Table VI A. (cont'd)

Vegetable Research Area (VRA) and RPA		Current[a/]	No Increase[b/]	10% Increase[c/]	Recommended[d/]
VRA - V	Nutritional and Organoleptic Quality and Regulatory Consideration				
RPA 402	Production of Vegetable Crops with Improved Consumer Acceptance	1.4	2.1	2.1	3.0
RPA 403	New and Improved Vegetable Products	2.7	2.0	2.0	2.0
RPA 501	Improved Grades and Standards	0.1	0.1	0.1	0.5
RPA 701	Toxic Residues in Food	1.8	1.8	1.8	9.0
RPA 702	Food Protection from Toxins	0.2	0.2	0.2	6.0
RPA 703	Food Consumption Habits	0.3	0.3	0.3	1.0
RPA 704	Home and Commercial Food Service	0.1	0.1	0.1	0.5
RPA 708	Human Nutrition	0.3	0.3	1.0	10.0
	Subtotal	6.9	6.9	7.6	32.0
	TOTAL	226.9	226.9	247.7	360.7

a/ Current data from CRIS printout FY 1972.

b/ No Increase - no change in funds for Southern Region.

c/ 10% Increase - 10% increase in funds for Southern Region.

d/ Recommended - Level within 10 years to provide solution to problem.

Table VI B. SCIENTIFIC MAN YEARS FOR VEGETABLE RESEARCH - SOUTHERN REGION**

STATE	Vegetable Research Area I	II	III	IV	V	TOTAL
Alabama	2.6	3.5	0	1.2	0.3	7.6
Arkansas	4.0	5.1	3.1	0.5	0.5	13.2
Florida	8.4	26.6	6.8	0.4	0.8	43.1
Georgia	2.1	6.2	3.4	0.8	1.0	13.5
Louisiana	3.7	6.1	0.2	0.7	0.3	11.0
Mississippi	3.9	7.2	1.2	0.6	0.5	13.3
North Carolina	4.7	8.1	3.1	1.1	0	17.0**
South Carolina	2.3	2.4	4.1	0.3	0	9.1
Oklahoma	0.8	0.7	0.1	0	0	1.6**
Kentucky	2.0	0.5	0	0	1.5	4.0
Tennessee	1.2	3.0	1.0	1.5	1.0	7.7
Texas	5.1	8.5	2.6	0.2	0.2	16.6
1890 Tuskegee	0	.2	.2	0	0	0.4*
USDA	8.8	13.7	12.4	7.6	0.8	43.3
Virginia	1.4	0	0.9	2.0	0	4.3*
P.R.	10.8	4.5	1.9	3.0	0	20.2
TOTAL	61.7	96.2	41.0	19.9	6.9	225.7

*From USDA Summary FY '72

**Updated by Task Force Members

Table VI C.
Acreage of major vegetable crops in Southern Region, 1971, as reported in USDA Agricultural Statistics 1972.
Does not include many smaller acreages of major crops.

	ALA	ARK	FLA	GA	KY	LA	MISS	N.C.	OK	S.C.	TEX	TENN	VA	TOTAL
BEETS											1600			1600
BROCCOLI											2100			2100
CABBAGE			17600	2500		2200	500	3200		850	20500		1450	48800
CANTALOUPE			1300	4900						3600	21800			31600
CARROTS											25500			25500
CAULIFLOWER											500			500
CELERY			11600											11600
CUCUMBER (FM)			1400					6200		6000	3000		2200	18800
CUCUMBER (PROC)								27300		9600	4700		2750	44350
EGGPLANT			1620											1620
ESCAROLE			6800											6800
LETTUCE			5300					250			8700			14250
ONION											24300			24300
PEPPER			13700			1300		8100			6800		800	30700
POTATO	17400	1400	36300		2500	2700	2000	14700			22300	4100	31000	134400
SPINACH (FM)											6300		1400	7700
SPINACH (PROC)		3300	1700						3500					8500
SNAP BEAN (FM)	1210		35400	4000		2400		9100		4200		1200	6200	63710
SNAP BEAN (PROC)	5000							1700	2300		3200	11800	2500	26500
SWEET CORN	2300		60000					5200			4900		2500	74900
SWEET POTATO	5300	1600		7800		37000	10000	23000		1300	10500	2300	7000	105800
TOMATO (FM)	7400	3300	34800	2800	750	1200		2800		7500	9300	2200	3000	75050
TOMATO (PROC)			3700								4100		5300	13100
WATERMELON	13500	6500	50100	33000		3300	10000	8200	12500	21500	60000			218600
TOTAL	52110	16100	281320	55000	3250	50100	22500	109750	18300	54550	240100	21600	66100	990780